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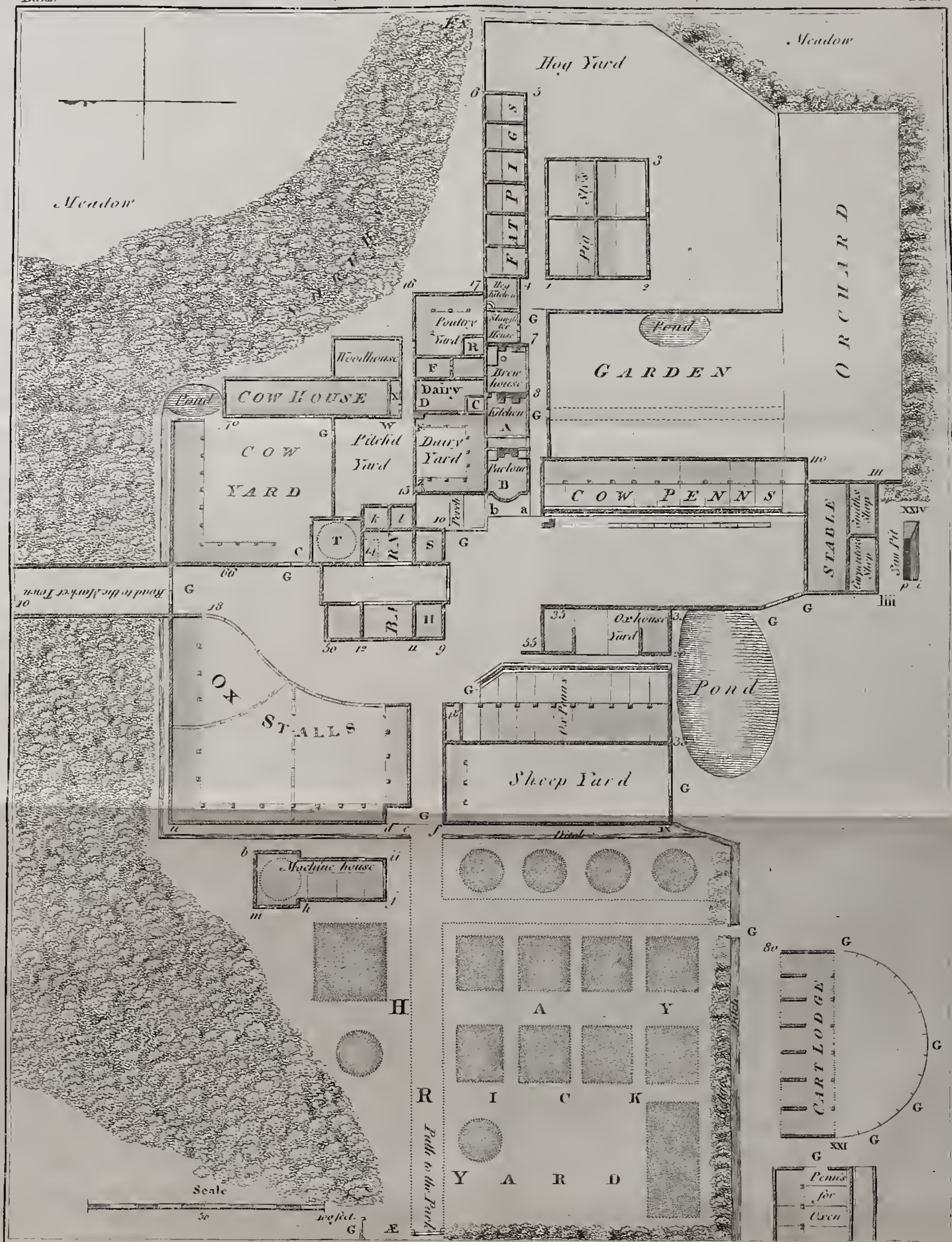

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THE

FARMER'S COMPANION;

BEING

A COMPLETE SYSTEM

OF

MODERN HUSBANDRY:

INCLUDING THE

LATEST IMPROVEMENTS AND DISCOVERIES,

IN THEORY AND PRACTICE.

ILLUSTRATED BY NUMEROUS ENGRAVINGS.

BY R. W. DICKSON, M.D.

AUTHOR OF PRACTICAL AGRICULTURE; OF THE SURVEY OF LANCASHIRE;
AND HONORARY MEMBER OF THE BOARD OF AGRICULTURE.

SECOND EDITION.

IN TWO VOLUMES.

VOL. I.

LONDON:
PRINTED FOR SHERWOOD, NEELY, AND JONES,
PATERNOSTER-ROW;
AND TO BE HAD OF ALL BOOKSELLERS.

1813.

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ADVERTISEMENT.

SINCE the first appearance of the author's SYSTEM of PRACTICAL AGRICULTURE, in two volumes quarto, he has been invited by numerous Land-owners and patriotic Country Gentlemen to print an abridged and cheap Edition of that Work, at a price suited to the literary views of Practical Farmers, and not exceeding what public-spirited Landlords might choose to give for Copies to distribute among their tenantry.

This cheap Edition, then, of PRACTICAL AGRICULTURE has been printed in conformity with those views, and under the more popular title of the FARMER'S COMPANION retains every established Principle, Fact, and Improvement in that noble Science, which constitutes the strength and wealth of a state, and which, if properly understood and pursued in Great Britain, would in a great degree counteract the baneful effects of perpetual warfare and increased taxation.

The author scarcely needs to observe, that although this new Work is engrafted on the former one, he has carefully revised every part, and introduced all the recent improvements in Agricultural Practice derived not only from his own observations but from the latest publications of the Board.

Hendon, April 17, 1810.

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INTRODUCTION.

AGRICULTURE, though it has probably made a greater progress in this than most other countries, is still far from having attained that degree of perfection which might have been expected, and of which it is capable:—much remains to be effected in almost every branch. If the state of the art be examined with attention, it will be found, that though in particular districts and situations its principles and operations may have been well understood, and the lands of course conducted under an improved state of cultivation; yet, that, on the whole, but a very small portion of the cultivated part of the island has even at this advanced period been brought under a judicious and well-conducted system of husbandry. Immense tracts of land of the more rich and fertile kinds may still be met with in different parts of the kingdom, that are managed in very imperfect and disadvantageous methods of farming. It has been stated by an able writer * that Great Britain contains SIXTY-SEVEN MILLIONS OF ACRES; SEVEN MILLIONS of which are taken up by houses, roads, rivers, lakes, &c., consequently incapable of cultivation; and that of the remaining SIXTY MILLIONS, only FIVE MILLIONS are employed in raising grain, and TWENTY-FIVE millions in pasturage, while THIRTY MILLIONS are either completely in a state of waste, or cultivated "under a very defective system of husbandry."

But it is not merely in regard to the cultivation of the soil that the advancement of the art has been so slow and confined; in other departments or branches its progress has been equally limited. In the management of meadow and pasture lands, and the improvement of the breeds of different kinds of domestic animals, except in particular instances, there appears to have been a still greater degree of neglect or inattention, though it must be allowed that regard is as necessary to be had to these as to that of arable cultivation; the connection between them being so intimate, that however well a farmer may be acquainted with arable practice, unless he, at the same time, possess the proper knowledge of improving and keeping his grass lands in order, and of breeding, rearing, and feeding animals, he must manage to very considerable disadvantage. Without this knowledge it is impossible for him to distinguish the different breeds of animals, or know that which is the most suitable and best adapted to the nature, situation, and circumstances of his farm, or to feed them in the most proper and advantageous methods.

In the instrumental part of husbandry, though much has been lately done, much is still to be accomplished before that degree of œconomy, convenience, and utility is attained that the subject is

* Sir John Sinclair.

capable of admitting, and which the nature of the art requires. It must however be allowed that valuable additions of this kind are daily introducing themselves.

The causes that have produced this slowness in the progress of an art, which undoubtedly claims the greatest regard and encouragement, are not only numerous, but extremely different in their nature. On a near investigation of the subject, it will probably be found that agriculture has, however, been less retarded by the incapacity or inattention of those who have been engaged in the practical part of the profession, than by the different regulations and restrictions with which it has been fettered, and which have been suffered to continue after the circumstances that gave them birth have been either entirely changed or have undergone very material alterations. It is not, however, on this account to be concluded, that the advancement of husbandry, as a science, has not been impeded by the influence of other causes; it has obviously been much restrained at all times, and especially in the more early periods of its cultivation, by the want of a clear and explicit knowledge of its principles, and of greater precision and correctness in the language made use of in their explanation. It has been observed by an able writer, that while a want of due precision and discrimination is suffered to exist in the definitions and descriptions of those substances which constitute the basis of agricultural knowledge, it is utterly impossible that agriculture can be carried to any degree of perfection as a science. It is from this ambiguity and incorrectness in the language of the art, that the cultivators of land in one part of the country are frequently incapable of profiting to any extent by the accounts that are given of what has been done by the exertions of those in another. This is sufficiently shown in what has been done in respect to the nature of soils; agriculturists in general having given such descriptions and definitions of them, as coincided with the notions that they had formed concerning their nature in their own particular districts or situations, rather than such as marked their particular properties and compositions. Knowledge of this kind, however just or accurate it may be in regard to the soil of the places from which such descriptions are drawn, must, he contends, be very imperfect in respect to others, and of course be incapable of any general application or utility. For it must be obvious to every one who is in the least degree conversant with the business of cultivation, that soils do not only differ very materially in the nature of their principal ingredients, but also in the proportions or quantities in which these enter into such compositions as are denominated soils. Thus the mere assertion of a soil being clayey, loamy, gravelly, &c., conveys little information, as it does not make us in the least acquainted with either the properties or proportions of the substances from which they are thus denominated. Besides, it is known to every farmer, that there is the greatest difference in the nature of clays and other substances which constitute the basis of soils as they exist in the state of earth or mould; the clayey soil of one tract of country being extremely fertile and productive, while that of another possesses the highest degree of sterility and barrenness. There are

likewise very considerable differences in the loamy and gravelly soils of different districts, which are by no means distinguished by such unqualified terms. For this reason it probably is, that experience in farming has had a less general effect in improving the science of agriculture than may have been supposed; and it is perhaps from the same cause, that the principal improvements in the profession have been confined to particular situations and districts, from which they have extended themselves by very slow and gradual means.

The difficulty of determining the connection of effects and their causes, and the length of time that is requisite to fully ascertain any particular fact or circumstance in farming, are also causes that have considerably impeded the scientific progress of agriculture. After much labour, time, and expense have been employed in order to elucidate and ascertain particular facts of this kind, it not unfrequently happens that the experimenters are incapable of accomplishing their objects, or of drawing such conclusions as can be safely depended upon; so various and so involved are the circumstances that influence the results of experimental attempts in this science. In this way, however, it is remarked, a sort of experience is begotten and transmitted in the art, which is difficult to be rejected; but which, if adopted, must often inevitably lead to error and disappointment in the practice of the farmer. Besides, this, as well as other sciences, has been greatly embarrassed and retarded by details of imaginary experiments and discoveries, which are very apt to impose upon the minds of those who are not very well informed concerning rural affairs.

There is likewise, it is added, in the business of agriculture, much confusion introduced by the difficulty which even the best judges frequently find in making their decisions, where a number of circumstances and causes are combined, concerning those which are essential and necessary to particular operations and processes, from such as are merely accidental and of little import. The want of correctness, too, in regard to the absolute expense incurred in accomplishing various operations in respect to any particular object of husbandry, and the difficulty, in many instances, of preserving the products of different trials distinct, have had a tendency to impede the advancement of the art; as from such inaccuracy the farmer is frequently incapable of ascertaining, with any degree of exactness, either the sum which he has expended or the value of the produce which he has obtained: consequently, he cannot be in a situation to estimate the advantages of such operations or processes; from which the profession remains where it was before the commencement of his attempts. The want of accuracy and precision in matters of this kind has also led to the introduction of an extremely pernicious system of proceeding in different instances, which is that of making conclusions by a sort of guesswork. Nothing can, however, be more fallacious than this mode of deciding; because a person under such circumstances is almost certain to be influenced by some preconceived opinion respecting the particular object of his decision. Facts collected and ascertained in this way, as they can but seldom have any solid basis, must of course greatly retard the

progress of agriculture. The conclusions that are drawn by means of experiment are even frequently liable to objection, and hence the improvement of the profession is not so much promoted by this method as many persons may suppose. In making such experiments as are to elucidate and explain the facts in this science which are doubtful or not well understood, much knowledge, care, and circumspection is constantly necessary on the part of the experimenter, to guard against every thing that may in the least degree influence the result: for, if this point be not carefully attended to, very different conclusions may be drawn from the same experiment. The farmer, from his not having been accustomed to that accuracy and precision which is requisite in this mode of inquiry, is often but indifferently prepared to avoid errors, which may be produced by a variety of unsuspected causes, that considerably influence the results of his trials. On this account, the inductions that are drawn from the experimental attempts of even real farmers can seldom be so fully depended upon as may at first sight be supposed: where due care and attention are bestowed, this is, however, the best and most certain means of increasing our knowledge, and extending the bounds of the art.

The want of a better and more complete knowledge of the different brances of science which are intimately connected with that of agriculture, among practical farmers, has not been less prejudicial to the improvement of husbandry, by the incorrectness and inattention which it may have caused in the ascertaining of particular facts and circumstances in the profession itself, than by the prejudice and attachment which it has engendered to particular customs, practices, and methods of management. The minds of those who ought to have been the most capable of enlarging the bounds of agricultural knowledge have frequently by this means been fettered, and kept from taking any new or particular views of the various objects and operations of husbandry. And this is, perhaps, one of the causes of farmers having proceeded so much in the same track since the commencement of the art.

That agriculture is capable of being advanced to a considerable state of improvement, by a more correct and general application of such principles and reasonings as are borrowed from other sciences with which it is connected, is extremely probable from the success and progress that has been made by the little that has been already done in this way, as well as from what may have been observed to take place in consequence of such application in other arts.

After this cursory view of the principal causes which appear to have impeded the advancement of agriculture as a science, we may proceed to those that operate against its extension and improvement as a practical art. Impediments of this kind are however so exceedingly numerous and complicated, that it is not intended to enter into any full or elaborate discussions respecting them; but merely to bring them to the notice of the agriculturist.

It is easy to perceive that a variety of obstructions must have been thrown in the way of agricultural improvement, by those slow and imperceptible changes that are continually taking place in the situa-

tion and circumstances of a country, by which laws, regulations, and restrictions, that were once proper and useful, become in the course of time highly detrimental and improper. From this cause it is that the early regulations that were made in respect to the management of lands in this island are so badly adapted for promoting the advantages of husbandry at the present period. This is fully exemplified in the case of commons. The ground in such instances does not merely lie in the state of waste, being debarred and deprived of undergoing any cultivation, although frequently very capable of admitting of it, but it is detrimental by preventing improvements in the adjoining lands from being carried on in the most complete manner and with the fullest effect, as well as by being exposed to injuries of the most baneful kind by the cutting away and removal of its surface, the sinking of pits, the stagnation of water, as well as a thousand other practices, while the nation derives not the smallest advantage from it in return for such a system of deterioration.

But it is not only in this point of view that commons are prejudicial or useless; they are a kind of property that has much effect in injuring the morals of the poorer classes of inhabitants who claim rights on them, by engendering quarrels and disputes, and relaxing those habits of industry, œconomy, and exertion, which are essential to the labourer in husbandry, by holding out to him a fallacious means of subsistence.

There is also a kind of *commonable* property which in some counties appears, from the late surveys that have been made, to be nearly one half of their whole arable territory; in which each individual knows indeed the limits of the land that he possesses, but is under the necessity of submitting to certain regulations and restrictions that custom has established, however absurd or disadvantageous they may be, in the cultivation and management of them. This circumstance, instead of exciting the farmer to industry and improvement, tends very materially to lessen his exertions, and introduce slovenly modes of practice highly prejudicial to the interests of agriculture. Lands conducted under such a system of management cannot probably be made to produce one half the quantity of grain or other substances, which they might be made to do under improved methods of cultivation. That great inconvenience and much disadvantage, in a national as well as individual point of view, arises from the possession of lands clogged with such customs, cannot be doubted; but perhaps the greatest mischief is the restraint which is thus imposed on the art of husbandry.

The tenures of land, in many instances, are not less injurious to the advancement of agriculture, than the circumstance of grounds being waste or in a commonable state. A large part of the land of this country is held under lords-of-manors, by a kind of copy-hold or customary tenure which subjects the tenants to the payments of fines on the decease of the lords or tenants, and on the alienation of the property, as well as certain annual rents, and in some places even to the performance of various disagreeable services; from which it is impossible that the holders of lands under such restricted conditions, especially where the lords are entitled to fines propor-

tioned to the improved value of such property, can be disposed to the expenditure of money, or the using of much exertion, in order to bring such lands into an improved state of husbandry. It has been justly observed on this subject, that "one great obstacle to improvement arises from a laudable anxiety in the customary tenants to have their little patrimony descend to their children. These small properties, loaded with fines, heriots, and boondays, joined to the necessary expense of bringing up and educating a numerous family, can only be handed down from father to son by the utmost thrift, hard labour, and penurious living; and every little saving being hoarded up for the payment of the *eventful fine*, leaves nothing for the expense of travelling to see improved modes of culture; to gain a knowledge of the management and profits of different breeds of stock; and to be convinced by ocular proofs, that their own situations are capable of producing similar advantages: and even should they be half inclined to adopt the new practice, prudence whispers, that should the experiment fail, it would require the saving of many years to make good the deficiency."

Such lands too as are held under corporations, whether they be civil or religious, as they do not afford the occupiers of them that kind of interest and security which becomes the stimulus of exertion and improvement, are of course detrimental to the progress of the profession. In lands of this tenure, no exchanges for the purpose of mutual accommodation and advantage can be entered into; no improvements in the way of cutting canals or laying out roads can be safely made, without the intervention of the legislature. But, what is still more hurtful, leases of very short periods can only be granted; from which circumstance such lands must constantly remain under very imperfect systems of management.

The possession of lands under deeds of entail may likewise be considered as prejudicial in the same way; as in such cases no inducement is held out for the expenditure of money, and the consequent improvement of such property.

But obstacles of a more general and powerful nature are found in the various indefinite claims that are made on lands. The payment of tythes in kind, from its operating directly as a tax on the capital and productive labour of the farmer and land-proprietor, as well as from its being vexatious in the mode of its collection, is a measure that impedes the improvement of the art of husbandry in a very serious degree. In the cultivation of arable farms, especially if the land be in such a condition as to require the expenditure of large sums of money in the purchase of manure, and considerable labour and exertion in other respects in order to bring it into the state of producing abundant crops, its effects are experienced in the most heavy, injurious, and oppressive manner. The efforts of the husbandman in this case have been "compared to those of a labourer, who should make considerable exertions during the hours of relaxation throughout the day, in order that he might obtain a bit of something hot for supper; and when he was just preparing to enjoy his hard-earned morsel, he had it taken away from him by a neighbour, who stood by idle all day, and now came, by means of a legal authority he had obtained as a reward for some exertions of

his predecessors, when the state of society rendered such a mode of remuneration the easiest of any that could then be devised, to seize that which the poor man gained by the sweat of his brow. Though the poor man is forced to give up his morsel in this case, it is impossible for him to yield it withont reluctance, or ever after to view his neighbour with a favourable eye. It provokes an invidious parallel to be drawn between the two parties, which estranges them the more from each other. The consequence is, that although, in this particular circumstance, the one gains just as much as the other loses; yet it tends very little on the whole to the emolument of the receiver, because the loser says within himself, since I cannot enjoy my own morsel myself, I can at least prevent my neighbour from getting it, for nobody can compel me to earn it but if I please. Thus down he sits in indolence; and neither of them enjoys the blessing that might have resulted from industry."

The spirited cultivator may be inclined to improve his lands, as is frequently the case, even where the profit he is to derive from such improvement cannot be considerable; but under such circumstances he must constantly be prevented from proceeding by the operation of this injudicious regulation: where a tenth or more of the produce arising from the exertions of the improver are to be taken away, it is obvious that small returns will answer; especially in business where there is much risk from season and other causes. By this means the community is consequently deprived of the various advantages resulting from increased industry and augmentation of produce. By the same system also, much good land, exclusive of commons and wastes, is constrained to remain in the unprofitable state of grass, which might otherwise, by a trifling expenditure of money, and no very extraordinary degree of exertion, be rendered greatly more productive under proper arable management. And it is likewise highly injurious in many instances, by subjecting the farmer to a disgusting dependence on the tythe-owner.

It is evident, that the effects of this measure must be equally detrimental to the interests of the proprietors of lands as to those of actual farmers; for whatever tends to lessen the exertion and industry of the latter must necessarily diminish the incomes of the former, and in a proportion much greater than is commonly supposed. But they are injured in another way besides that of rent; for as a tenth of the produce of the lands is thus taken away in kind, a deficiency of manure to that extent must be the consequence, the disadvantages of which are now generally well understood. The effect which the abolition of tythes in Scotland has had in promoting agricultural improvements, also, affords a strong and satisfactory proof of their operating powerfully against the advancement of husbandry; for it cannot be attributed to any other circumstance that improvements have been carried on so much more extensively in that part of the island than in this.

But it is not merely in stopping the progress of agricultural improvements that the payment of tythes in kind is prejudicial, its effects are injurious in many other points of view which it is unnecessary to consider at present. It is therefore a matter of the utmost importance that such an alteration or modification should be effected as might

render the claims of the proprietors secure, without producing those mischievous consequences which proceed from it in its present form.

The present method of providing for the poor, notwithstanding the judgment and deliberation with which it was adopted, is unquestionably detrimental to the advancement of agriculture, as well as greatly prejudicial to morals and industry, from its falling disproportionately heavy on land holders of every description—nearly three-fourths of the whole amount of the immense sum being raised by that class of society. The proprietors of land are, however, in some measure enabled to throw this burthen from themselves by stipulating with their tenants for the payment of all parochial taxes, so that in fact the farmer becomes the principal sufferer, especially in cases where any augmentation of the assessment is required, which is frequently the case from the operation of either local or general circumstances; such as the failure of manufactures, to the carrying on of wars. By these means the capital of the farmer is diverted from its proper application, that of being employed in the cultivation and improvement of land; by which the progress of husbandry is not merely impeded, but the community sustains an incalculable loss.

There are still other obstacles which retard the improvement of the art besides those that have been noticed; but they are in general either less prejudicial in their tendency or more limited in their operations. Of this kind are, the game, the corn, and the salt laws; all of which in their present forms throw great impediment in the way of agriculture. And the want of proper and convenient roads and markets in many situations, for the conveyance and disposal of different kinds of produce, and of easy and expeditious modes of conveying them to such places, as well as a variety of local customs and regulations, are not less injurious in their effects, though much less attended to.

These are some of the principal difficulties and impediments that have been so long suffered to retard the progress of cultivation, and which must continue to put an insuperable bar to its improvement, in many respects, until they are removed.

But the advancement of agriculture has not been solely obstructed by causes of this nature: there are many others which the proprietors of lands have the means of obviating. The want of proper and judicious leases has at all times operated unfavourable for the improvement of husbandry, and is an evil very generally complained of by farmers; a circumstance which is not in the least to be wondered at, as it can hardly be supposed that improvements will be carried on to any extent where there is a want of permanent security for the enjoyment of those advantages that may be derived from them.

It has been justly remarked by Mr. Donaldson, that "that man would certainly be justly subjected to the reproach of being rash and inconsiderate in his conduct, who should expend money and labour on the improvement of any farm, where his certainty of continuance does not entitle him to look forward with a confident assurance to the period when his exertions are to be rewarded. It is a well-known fact, that the hope of reward sweetens labour; take that away, and the spur to labour ceases. It is that alone that calls forth industry,

and is the spring of all exertion. What object, then," says he, "can a farmer have to hazard his capital, and devote the most vigorous and active part of his life to the improvement of a farm which he holds on no more certain tenure than the will, or, in other words, than the whim or caprice of his landlord? In every such situation, the prudent farmer must be restrained from any spirited expenditure, however much he may be satisfied that the improvements which might thereby be effected would, under other circumstances, prove beneficial to the public, the landlord, and himself. Have not instances occurred, where tenants so circumstanced have been obliged *repeatedly* to agree to pay advances of rent rather than remove; while, from the uncertainty of the tenure on which they held their farms, they were debarred from making those exertions which an advance of rent demanded, and which almost uniformly takes place in such cases when leases are granted?"

From an examination of the excellent surveys that have lately been made of the agricultural state of the kingdom, under the direction of the Board of Agriculture, it appears that by far the greatest part of the land in many counties is held by tenants merely at the will of their landlords, who of course may deprive them of their farms, on proper notice being given, whenever they please; and in cases where leases are granted they do not extend further than from five to nine years, except in a very few instances indeed, in which they may be protracted to the period of nineteen or even twenty-one. And even such leases as these are for the most part clogged with such restrictive clauses and conditions as put a stop to improvement, and confine the cultivator in methods of management that are frequently far from being the most advantageous.

In the first case, indeed, the farmer is kept in such a state of dependence as is not only highly degrading, but must effectually damp and repress his exertion and industry. And the tenants under short leases are not in situations much more desirable, as they cannot with safety or propriety enter into any extensive beneficial methods of augmenting the produce of their farms, lest the advantages should be reaped by others. Even a lease of twenty-one years, in many situations and under different circumstances, is not sufficient to allow the farmer to undertake improvements of considerable magnitude; as he can neither conduct them in the most economical way, nor reap the full advantage of them. Besides, where money to any great amount is expended in the beginning of such a term, the farmer is often, in order to indemnify himself, where he has not a prospect of remaining, induced to run out and exhaust the land at the latter end of his lease; which is a practice of the most prejudicial tendency to the proprietors of such farms, and the community, as well as the interests of agriculture.

It is evident, therefore, that the farmers of land should in *all* cases have such a security for the possession of it, as will enable them to introduce the most improved modes of management, and excite them to adopt the best means of improvement. The length of lease that may be most suitable and best adapted to these important purposes is not easily ascertained; it ought probably to vary according to the particular circumstances and the nature of the im-

provements that are to be carried into execution. In such leases many clauses must of course be requisite; but they should be such as are plain and simple, and such as may not too greatly destroy the independence of the farmer, but leave him much at liberty to follow his own plans of cultivation; while they afford effectual security to the proprietors, by cautiously guarding against the introduction of such systems of husbandry as would be injurious or improper.

From what has been observed, it is evident that different circumstances must be attended to, in order to bring the state of agriculture to that degree of perfection which its utility demands. It will not only be necessary that the principles of the art be rendered more clear and easily accessible to the cultivator, but that the various processes and practices be brought into a more obvious and intimate connection with them, and more full and complete explanations of the nature and constituent properties of the different substances or bodies that enter into and form the basis of the profession afforded; as well as the different clogs and impediments, which have been interposed at different times, in the way of regulations, obviated and removed. The author has endeavoured as much as possible in the present work to furnish the farmer with a more correct knowledge of the qualities and methods of operation of those materials or substances with which he is to accomplish his various purposes, as well as the changes which they undergo by an intimate combination with each other; and the modes in which they may be applied and made use of with the greatest chance of success and advantage.

The former of the above circumstances, or those which relate to the connection between the principles and practice of husbandry, have been objects of much consideration and regard. It has also been his wish to extend the bounds of his information in respect to the means of cultivating the different plants which constitute the food of man, or which serve for the purpose of feeding cattle and other domestic animals. In this intention, the various improvements that have been effected in the nature of tillage, and the interposition of different sorts of green crops with those of the grain kind, as in the implements and machinery by which they may be performed with the greatest œconomy and convenience, have been brought to his notice in as clear and concise a manner as the nature of the subject admitted.

And as the various products of the earth can only afford a trifling advantage to the cultivator, unless he be perfectly acquainted with the means of applying them as the food of animals, the methods of management that appear the most beneficial in the breeding, rearing, feeding, and fattening different sorts of live stock, have, it is hoped, been more fully explained, and placed in more clear and distinct points of view.

In regard to the latter, or the removal of those obstacles which have been thrown in the way of agriculture, under the idea of regulating its operations, however necessary it may be to the complete improvement of the art, it can only be effected by the interposition of the legislature and the proprietors of land.

THE FARMER'S COMPANION.

PART THE FIRST.

MACHINERY, BUILDINGS, INCLOSING, ROADS, AND EMBANKMENTS.

SECTION I.

Implements of Husbandry.

THERE is scarcely any part of the extensive and important science of agriculture that has received greater improvements within these few years than that which relates to the construction of the implements which are necessary to be employed. Since a taste for the art has fortunately been diffused through the country, and men of great knowledge and fortune have been induced to engage in it, persons of ingenuity and mechanical talents have been brought forward and sufficiently encouraged to exert themselves either in the improvement of the better kinds of the old instruments, or in the invention of new ones; by which means more convenient and useful instruments and machines have been provided for almost all the various operations and processes that are continually to be performed in cultivating land, and managing the different kinds of business necessarily connected with it. Among the variety of different implements which have been thus presented to the attention of the agriculturist, some, as may easily be conceived, have appeared that are evidently much too expensive and complicated in their construction for the purposes which they are intended to serve; and others, probably from a want of practical information in the inventors, have not been properly adapted to the uses for which they were designed; but in general they have been such as have contributed much to the present very improved state of the art.

The backwardness that may be observed, and which is so much complained of in some particular districts in respect to the state of their cultivation, would seem to depend, in some measure, on an attachment to such implements as they have been in the habit of employing, however imperfect they may be, in preference to such as have been recently invented or improved. This, in some cases, too, may probably arise from the want of capacity in the farming labourer to make use of new tools with ease and convenience to

himself; and in others from farmers themselves being frequently unacquainted with the instrumental improvements that have been made, or not sufficiently convinced of the advantages that may result from the use of them.

In the construction of every sort of tool for the purposes of farming, as the chief objects ought to be the rendering the business of husbandry more complete, easy, and expeditious, and the introduction of a system of economy in respect to the labour that necessarily attends it, great care should be taken that they be well adapted to the purpose for which they are intended, and not unnecessarily heavy, while they possess sufficient strength and firmness for the various uses to which they may be applied. It is well observed in an ingenious and interesting periodical publication, that there are no sort of implements that admit of greater improvement than those of husbandry, on the principle of diminishing weight without in any degree abating their strength. "Every man knows," says the author, "that if a beam of any length be made of equal thickness throughout its whole length, and a weight sufficient laid upon it, it will inevitably break in the middle, and never at either of the ends; yet, unless it be in the poles of a sedan-chair, he can scarcely recollect an instance in which weight has been diminished upon this principle. On the contrary, it is not at all unusual, in the construction of such implements, to see the thickness diminished nearly one-half at the very weakest place by means of a mortise cut out in it there, while its thickness in other places is four times greater than would enable it to bear an equal burden. No attention is paid to placing the wood in that position wherein it would be best able to resist the pressure to which it must necessarily be subjected; although it is very well known, that the same quantity of materials may be made to bear in one position above *ten* times as much as it could do in another. It is well known, that mortises weaken the wood to an astonishing degree when injudiciously placed; yet it is no uncommon thing to see two cross-mortises, each of them of twice the size that in any case could have been necessary, made through a beam perhaps at the very weakest parts of it, just as accident may direct, without even an attempt to vary their position, far less to avoid them entirely, which in many cases might be done without the least inconvenience. It is well known that a small brace, judiciously applied, may greatly augment the strength without adding to the weight of an implement; yet contrivances of this kind, which are obvious to the merest tyro in mechanics, seem to be totally disregarded; far less do the constructors of such tools think of adopting new devices of this sort, which a very moderate degree of ingenuity might easily suggest. The importance of having every part firm and compact in an implement that is subjected to jolts and shaking is universally recognised; yet, from the most trifling considerations, we see this principle departed from, and loads of superfluous materials added, in vain, to supply the defects that are thus produced." He concludes by observing, that "it is not to one implement only that these observations apply, but to almost every common implement of agriculture."

The above principles, though extremely plain and obvious in themselves, are circumstances which seem indeed to have been greatly overlooked by the practical farmer; and too little regarded by those who have been principally employed in making instruments of this nature; as in almost every district of the kingdom, notwithstanding the many useful inventions and improvements which have lately been made, we may still meet with different sorts of implements that are not only exceedingly awkward and inconvenient from their clumsiness, but which are used with much disadvantage, on account of their great weight: situation, and some other causes, will, however, render a difference in regard to strength, and other circumstances, necessary, and by them the operator must frequently be guided in the construction of tools for the purposes of husbandry. As most of the implements of this kind are made use of by persons who have but little knowledge of the nature, power, or action of machines, and as they should be generally in the hands of farmers, they ought always to be constructed upon the most plain and simple principles, of such kinds of materials, and in such ways, as that they may be afforded at a cheap rate; nothing having operated more unfavourably to the introduction of new implements among this class of men than the great expense that attends the procuring them.

Ploughs.—As ploughing, like many other operations in practical husbandry, must often vary in the manner of its being performed, it is evident that no one particular sort of plough can be superior to all others, in every season, and under every variety of soil, or inclination of surface; different soils, situations, and uses, will of course require different kinds of ploughs, though there are, undoubtedly, some that are capable of a much more general application than others. It has, indeed, been observed by the author of a late work on husbandry, that "the plough which costs the least money, is the lightest to trail, and makes the best work, is of most value;" which, in general, is without doubt correct.

In the forming or constructing of all sorts of implements of this kind, there are a few general principles that ought invariably to be attended to; such as the giving the *throat* and *breast*, or that part which enters, perforates, and breaks up the ground, that sort of clean, tapering, sharpened form, that affords the least resistance in passing through the land; and to the *mould-board* that kind of hollowed-out and twisted form, which not only tends to lessen friction, but also to contribute greatly to the perfect turning over of the furrow-slice. The beam and muzzle should likewise be so contrived, as that the moving power or team may be attached in the most advantageous *line of draught*. This is particularly necessary where a number of animals are employed together, in order that the draught of the whole may coincide.

It has been suggested by an able agriculturist, that the breast of a plough should be long and narrow, making an acute angle with the beam; the length of the breast tends to preserve the *flag* from breaking, the surface for its support being large. This is a very

important consideration in ploughing old leys for wheat, pease, &c. as a number of weeds are thus smothered which would otherwise insinuate themselves through the interstices of broken ground. The resistance of the earth against the breast is also obviously diminished in proportion to the acute angularity of the breast against the beam.

Swing Ploughs.—As this sort of plough is not encumbered with wheels, it must be most free from friction, and the resistance which necessarily proceeds from that cause; consequently may, in general, be said to be the lightest of draught.

In the construction of ploughs of this kind, there is, however, considerable variation in different districts; but when they are made of proper kinds of materials, and in the most improved manner, they must be allowed to be instruments of extensive application and utility; as, besides being effective in their operations, they are not so easily put out of order as other more complex kinds of ploughs; and, from the circumstance just noticed, require in almost every kind of soil, when managed by a good ploughman, much less strength to draw them than those of a similar kind when constructed with wheels; consequently give considerably less fatigue to the horses, or teams of any kind, that may be employed in drawing them. In the throat and mould-boards of most of the improved ploughs of this kind, there is that peculiar form of curvature which lessens resistance in turning up the ground, and which contributes to render the earth of the furrow equally and well laid over to its situation.

The *Rotheram plough*, *Small's chain-plough*, and a *plough* recommended by the Board of Agriculture, as well as several others to be met with in almost every arable county of the kingdom, are formed in this way. At fig. 1. in the annexed plate, is given a representation of the Rotheram or patent plough. As this sort of plough is not encumbered with wheels, it would seem to be the most free from friction and the resistance which necessarily arises in that way; consequently, may in general be said to be the lightest of draught. At fig. 2. is shown *Small's chain-plough*, which will be found highly useful in cultivating strong and rough grounds; for, should the share, or coulter, suddenly meet with any obstruction, the strain is immediately thrown upon the chain, instead of the beam. And at fig. 3. is a *swing-plough*, with Lord Somerville's improved mould-board; with which, from the clean sharpened construction of the breast and throat, deep stiff land may be broken up with great success; and, as the extremity of the mould-board is moveable, the furrows be laid more or less flat, according to the circumstances of the case.

Light thin soils, with little tenacity of surface, such as are commonly employed in the growth of turnips, may be well managed by almost any of the ploughs that are in general use; but as the chief excellence of a plough for this sort of soil would seem to be that of its possessing light weight, easy draught, and being capable of leaving the surface in any desired shape in respect to height of ridge, those of the light swing kind ought certainly to be preferred,

SWING PLOUGHS.

Fig. 1.

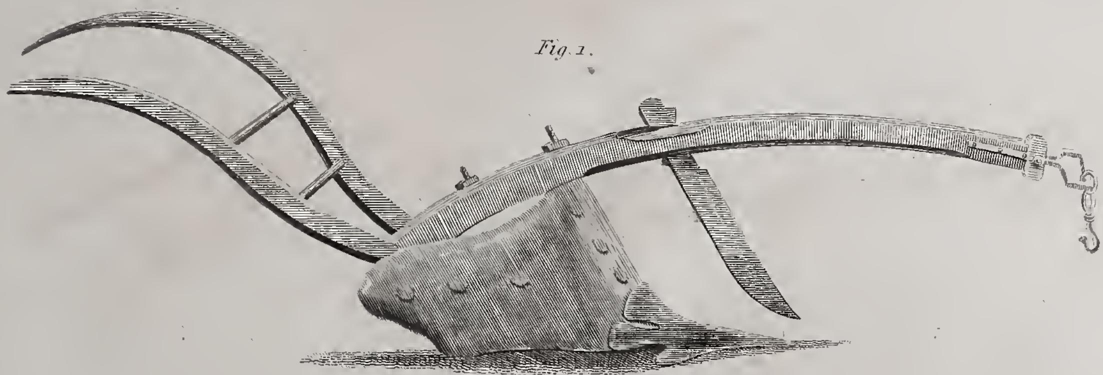


Fig. 2.

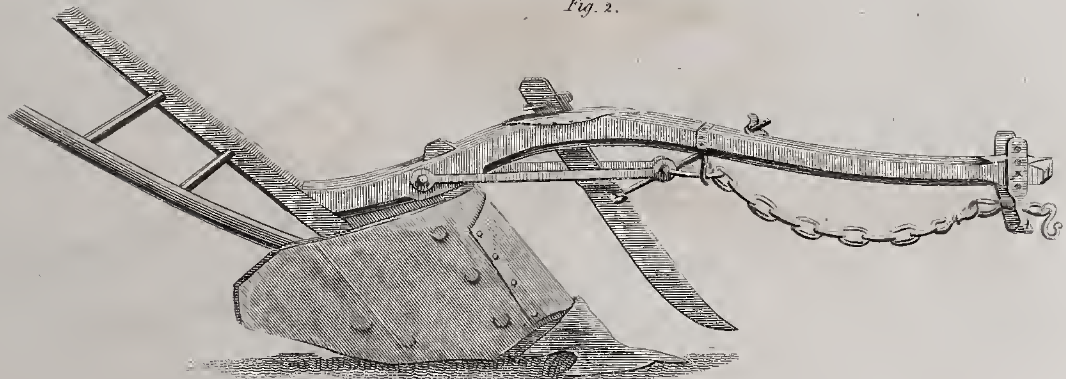
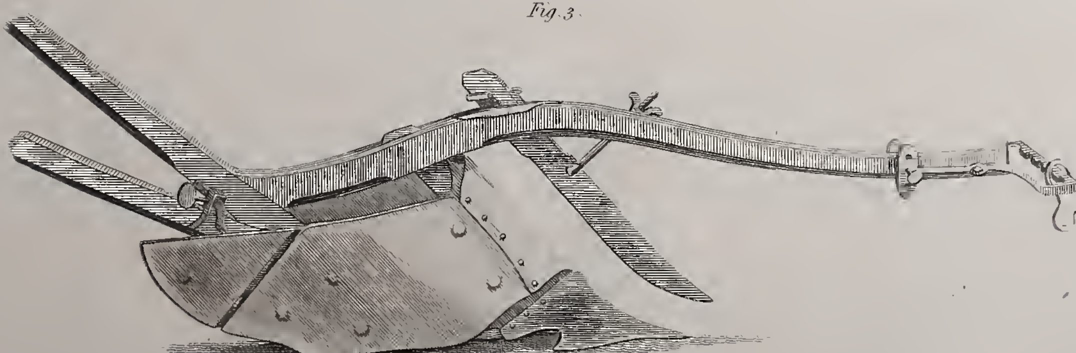
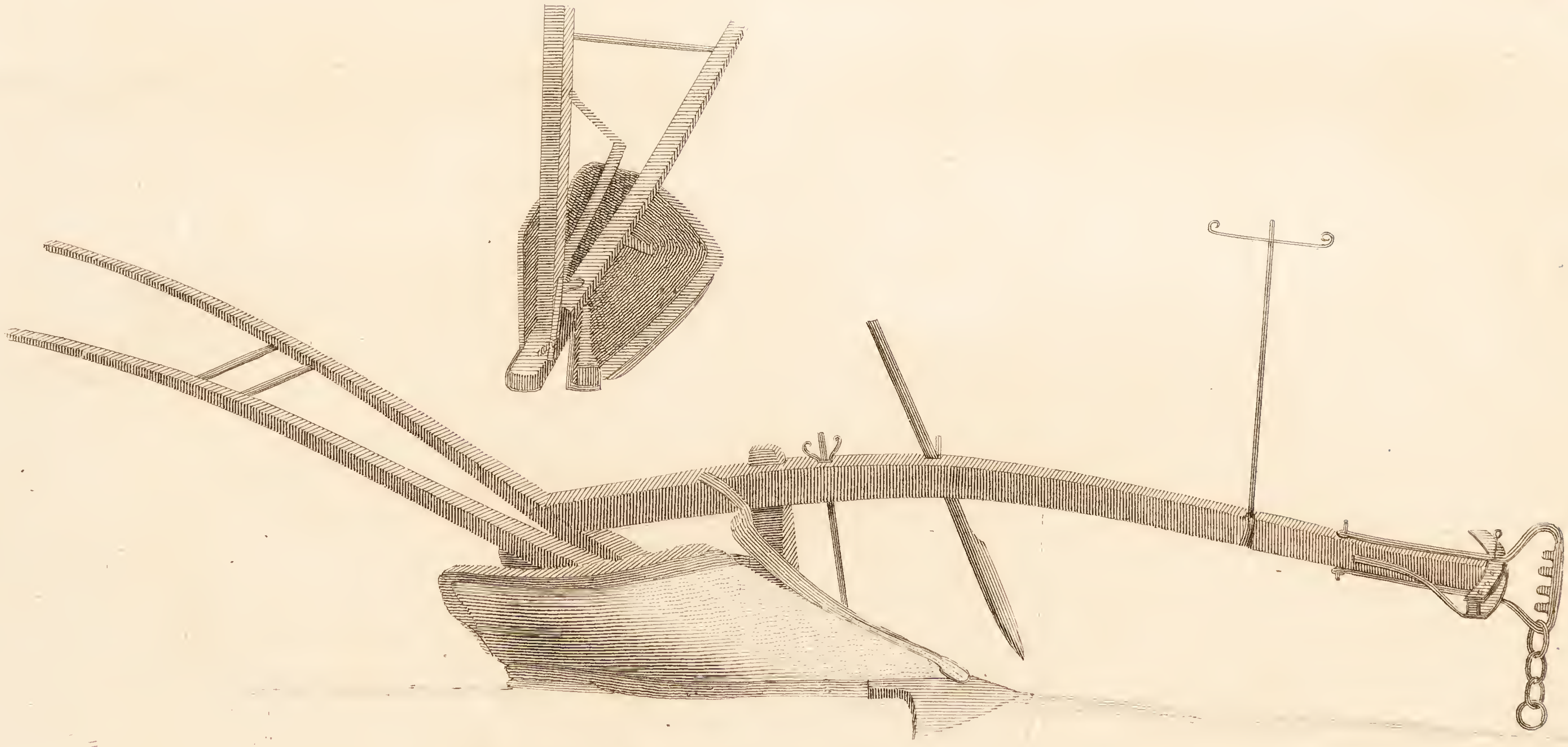


Fig. 3.



PL. III. *Page 15*



Neele sc. Strand.

Mr. Western's Plough, with improved Breast.

Ploughs of this sort have for some time been much employed in most of the northern counties, and in the southern districts are now much more frequently met with. In many places they do not cost more than forty or fifty shillings. That sort of plough which is commonly known by the name of *Dutch plough*, is a light swing-plough, which, from its not requiring great strength to draw it, may frequently be used with advantage on some of the lighter sorts of soil, which are pretty free from stones and other obstructing matters of that nature. But where the land is of a strong, heavy, cohesive quality, and where the roots of vegetables, or other substances, afford considerable resistance and obstruction, a much stronger plough must be employed. Here the *Suffolk iron swing-plough* will, probably, be found a much better, as well as a very necessary and useful instrument, especially when managed by a judicious ploughman. The advantage of this instrument has been particularly shown in breaking up some of the strong heavy lands of the King's farms, in the great park near Windsor. It not only does its work well, but with greater facility than many other kinds of ploughs which are frequently employed on these kinds of soil. The part to which the team is attached, in this sort of plough, is an excellent contrivance for the purpose which it is intended to serve. A *swing-plough* used by Mr. Western in Essex, with an improved breast, is also an useful plough. It is seen in plate III.

Wheel-ploughs.—The manner of constructing these ploughs, like those of the swing kind, varies considerably in different places, according to the nature of soils and other circumstances; but in every form, and in all situations, they probably require less skill in the ploughman. Wheels seem, indeed, to have formed an addition to ploughs, in consequence of the want of experience in this class of men; and in all sorts of soil, but more particularly in those which are of a stony and stubborn quality, they afford great assistance to such ploughmen, enabling them to perform their work with greater regularity in respect to depth, and with much more neatness in regard to equality of surface. From the friction caused by the wheels, they, however, give much greater resistance, and consequently demand more strength in the team that is employed; and, besides, are more expensive in their construction, and more liable to be put out of order, as well as more apt to be disturbed in their progress by clods, stones, and other inequalities that may be on the surface of the ground, than those of the swing kind.

It is also observed by a late ingenious writer, who seems to have paid much attention to the invention and improvement of implements for the purposes of husbandry, "that with *wheel*-ploughs workmen are apt to set the points of their shares too low, so as, by their inclined direction, to occasion a heavy pressure on the wheel, which must proceed horizontally:" the effect of this struggle he conceives to be an increased weight of draught, infinitely beyond what could be supposed: for which reason, he thinks the wheel is to be considered as of no importance *in setting a plough for work*; but passing lightly over the surface, it will be of material aid in

breaking up old leys, or ground where flints, rocks, or roots of trees occur, and in correcting the depression of the shares from any sudden obstruction, as well as in bringing it quickly into work again, when thrown out towards the surface.

But an able writer, in speaking of the agriculture of Middlesex, though by no means an advocate for wheel-ploughs, remarks, that "on a comparative view of the whole of any two extensive districts, whereof one is tilled with wheel-ploughs, and the other by swing ones, as Berkshire and Norfolk against Middlesex and Surry, including every description of ploughmen usually met with in those counties, it has appeared to him, on many occasions, that for neatness of work wheel-ploughs have the advantage. This circumstance, and keeping the men in good temper, is, he thinks, probably of more consequence than a little disparagement in point of draught."

Notwithstanding this, the objections which we have just mentioned, the weight of the carriages for the wheels, and the trouble of fixing and moving them, are inconveniences that operate strongly against the use of this kind of plough in all cases, but more particularly in those of general tillage.

An intelligent farmer in one of the midland districts, however, assures us, that the Rotheram-plough, with one or sometimes two wheels fixed near to the end of the beam, without any carriage, goes very light, and is very useful; such alterations as are necessary requiring very little time or trouble. Where two wheels are employed, the plough does very well without a holder on a good tilth or light sward, where there are few stones, except at the setting in and turning out.

Wheel-ploughs should, however, probably be seldom had recourse to by the experienced ploughman, though they may be more convenient and more manageable for those who are not perfectly informed in that important and useful art.

This sort of plough will, in general, be found most suitable for the more stiff tenacious soils, and those in which stones, flints, or other obstacles of the same kind abound, the most advantageous and desirable properties under such circumstances being those of strength, and of not being easily thrown out of the ground. For general purposes in such soils, perhaps, the *Hertfordshire wheel-plough*, which has a piked share, may be the most suitable implement; but where the ground is very strong, and where very deep ploughing is required, the *Kentish turnwrest-plough*, with a chisel-pointed share, should probably be preferred.

On light, loamy, and friable soils, where deep ploughing is not necessary, the *Norfolk wheel-plough* will be found a convenient and useful tool, as being compact and light in its form, doing its work with neatness, and requiring only a small draught.

At fig. 1. in plate IV. is seen the *turnwrest* or *Kentish plough*, a powerful implement in such stiff strong soils, but very heavy. It is used in Kent with four horses abreast, and answers well in such circumstances as have been mentioned, as well as in dry soils, from its going deep and laying the furrow-slice quite flat,

PL. IV 8b

KENTISH AND NORFOLK PLOUGHS.

Fig. 1.

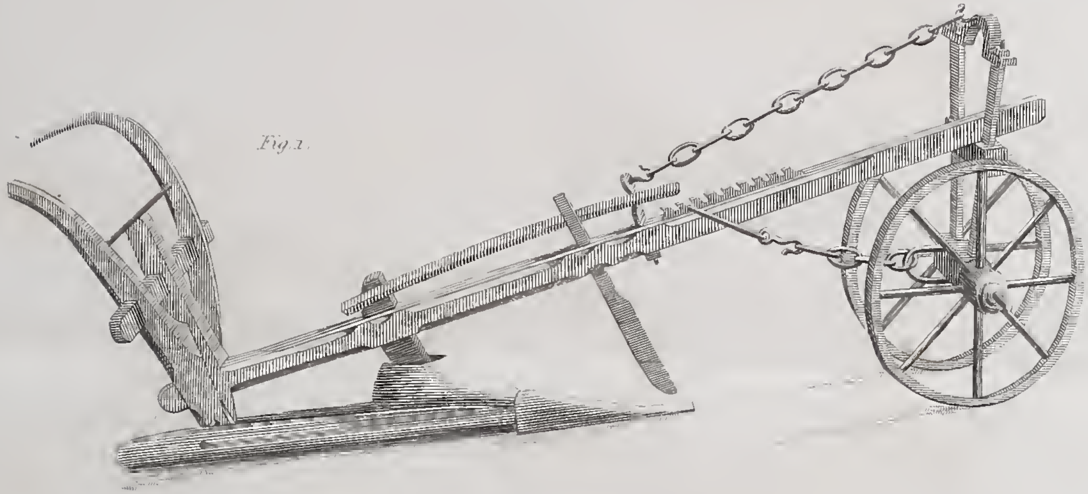
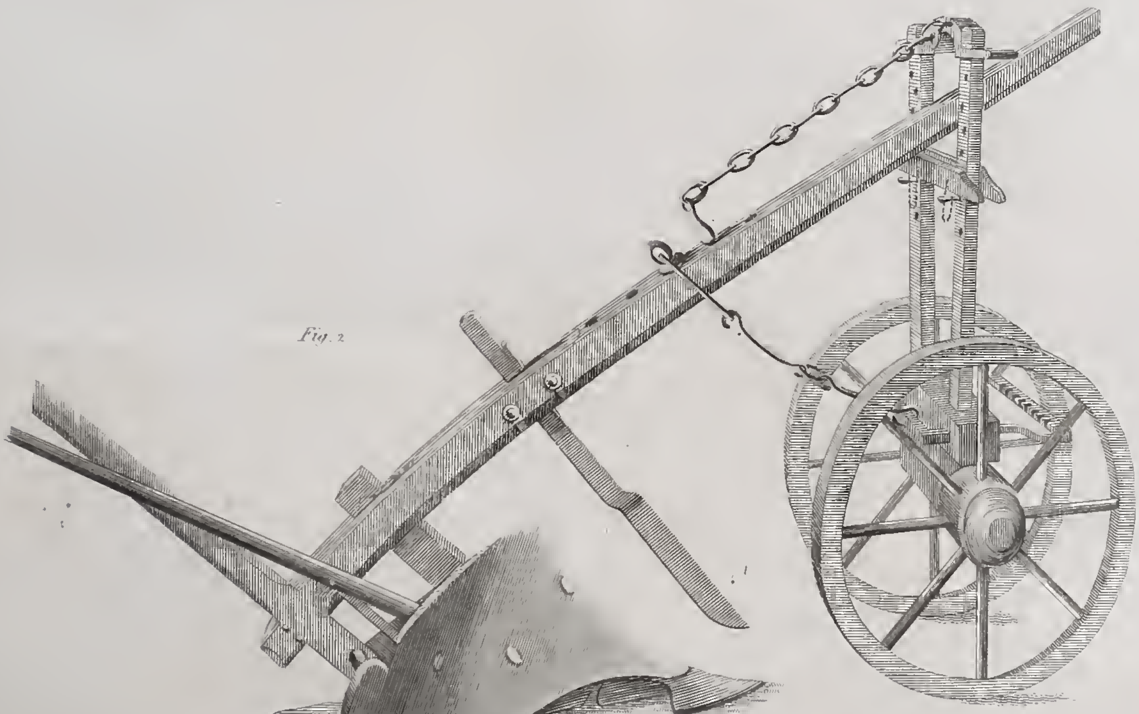


Fig. 2.



Improved Wheel Plough.

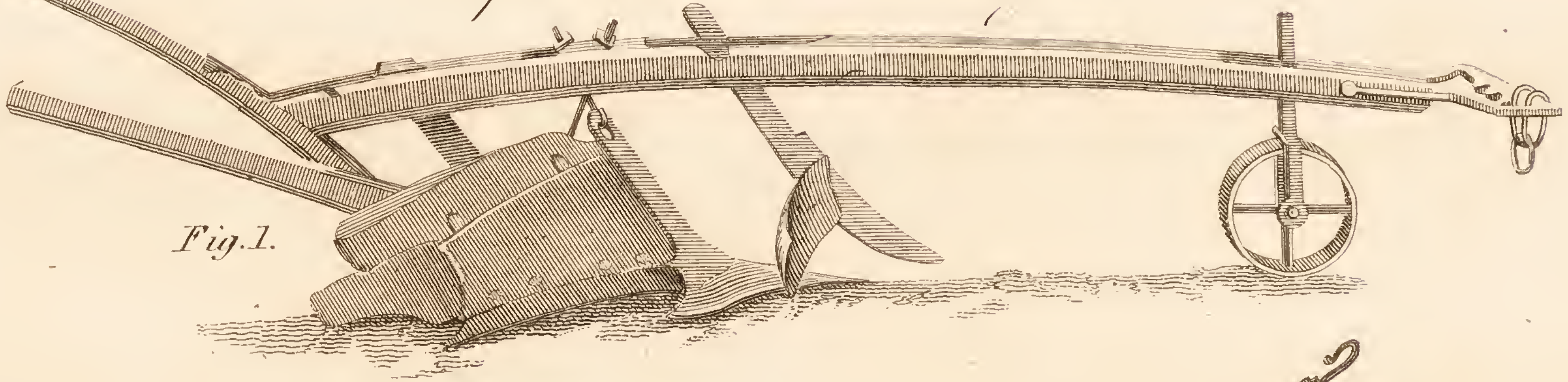


Fig. 1.

Beverstone Wheel Plough.

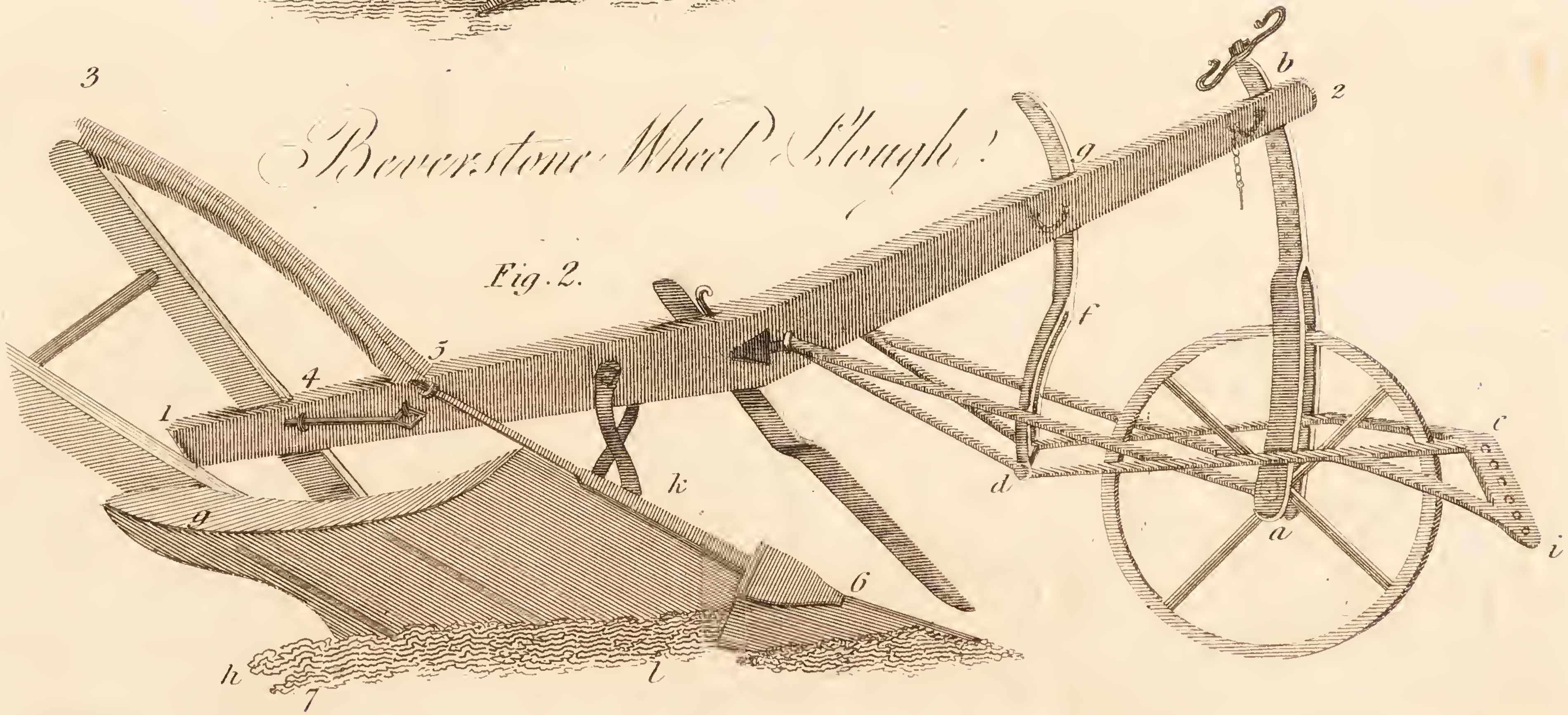


Fig. 2.

without any opening in the seam. It costs, complete, *5l. 5s.* Mr. Boys describes it as consisting " of a beam of oak ten feet long, five inches deep, and four broad; behind which is a foot, five inches by three and a half, and three feet and a half long, on the top of which the handles are placed; the foot is tenoned to the end of the beam, and mortised at the bottom to the end of the chep. Through the beam, at two feet five inches distance from the foot, is a sheath of oak seven inches wide and one and a half thick, which is mortised into the chep in an oblique direction, so that the point of the share is twenty-two inches distant from the beam. The chep to which the share is fixed is five feet long, four inches wide, and five inches deep. The share, of hammered iron, weighs about thirty-two pounds, is twenty inches long, and from four inches and a half to seven inches wide at the point.

" The upper end of the beam rests on a carriage with two wheels, three feet two inches high. On the axle-tree is a gallows, on which is a sliding bolster, to let up and down. Through the centre of the axle is a clasp-iron, to which is fixed a strong chain called a tow, that comes over the beam, so fixed, as by means of notches (or a pin called a check) to let the whole plough out a greater length from the axle, thereby letting it down to a greater depth."

A representation of the *Norfolk plough* is given at fig. 2. in the same plate. The head and beam are short, but the carriage part or wheels stand high; by which means the fore end of the beam is much raised, and the horses are more conveniently driven. It is usually drawn by two horses a-breast, the ploughman guiding them by reins.

The *Rotheram-plough*, with a wheel as above, might probably, in many cases, be made use of with equal if not greater advantage than the above, from its being very light, and requiring little strength in the team, and which is in many districts the common sort of plough.

The *double mould-boarded wheel plough*, employed for the purpose of setting potatoes, cabbages, and other similar crops, and for earthing up crops sown or set in rows at great distances, is likewise a very useful sort of tool of this kind.

The improved *common wheel-plough*, and likewise the *two-wheel plough*, are implements which will be found useful in certain kinds of soil where the more complex ones cannot be employed, as in breaking up fresh grounds, &c. The former has been lately much improved by the addition of an iron earth plate firmly screwed to the coulter, which in some places is called a *flay*. It is made use of when ploughing turf, by which it is taken off and turned into the furrow, when the plough immediately covers it with earth. It is observed that, by this management, turf, at one ploughing, has the appearance of a fallow, and harrows nearly as well. A little more strength is however required in the team. This is seen at fig. 1, in plate V. And another *Improved wheel-plough*, invented by Mr. Tugwell, is represented at fig. 2, in the same plate. In this, the principle, or point of draught, though expensive in the iron work, is, according to Lord Somerville, " most effective:" it is

"*perpendicularly above the point of action*, namely, the throat, or breast, where the share fits on." The different dimensions of this plough are:

	Ft.	In.
From 1 to 3		0
3 to 4	3	8
3 to 5	4	3
5 to 6	2	5
7 to 6	2	8
1 to 3	1	5
1 to 8	2	10
1 to 9	4	8
Heel to tuck hole of share	2	$6\frac{1}{4}$
Tuck-hole to point of share	0	$8\frac{1}{2}$

	Ft.	In.
From a to b	2	4
d to e	2	5
c to d	1	4
d to e	2	5
Diameter of the wheel	1	9
d to f	0	11
g to h	0	$10\frac{1}{2}$
e to i	1	$3\frac{1}{2}$
k to l	0	9
Breadth at heel	0	9
Breadth of fin	0	7
Top of beam at the heel to ground	0	$8\frac{1}{2}$
Mould-board projects at top more than breadth at heel	0	6

It is sometimes termed the *Beverston plough.*

The latter, or *two-wheel plough*, is made use of in the midland districts, and has generally a check-chain, by which the wheel is pulled up, in order to be out of the way in opening ridges and clearing up furrows.

The *two wheel plough* used in Sussex for light soils, which is usually drawn by two horses a-breast, directed by the holder by reins from the handle, and works steadily, dispatching much work, is also a good plough. Ploughs of this sort are made by Wingham of Nut Bourn, near Chichester.

There is also in some of the fen districts a kind of *wheel-plough* which has much resemblance to the Dutch paring-plough employed in Cambridgeshire, which is a good instrument for ploughing where there is much stubble, or where the want of proper management in the farmer has suffered twitch-grass to become abundant. The mould-board in this plough has a good sweep, and the share a proper form, which should be constantly kept sharp by means of files, and be well steeled. The coulter in this sort of plough is a steel wheel, which is well adapted for the purposes we have just mentioned. Mr. Young, in his account of the agriculture of Lincolnshire, remarks, that Mr. Cartwright affixes to this plough a bean-drill of great simplicity, that drills upon the centre of the preceding furrow while the next is turning; with which apparatus it must be a very convenient and useful implement for a variety of purposes in arable husbandry. It has been found useful in Lincolnshire.

In plate VI. is a representation of the common *Essex wheel-plough* used on the farm of Mr. Western. In plate VII. is seen the common *Berkshire wheel-plough.*

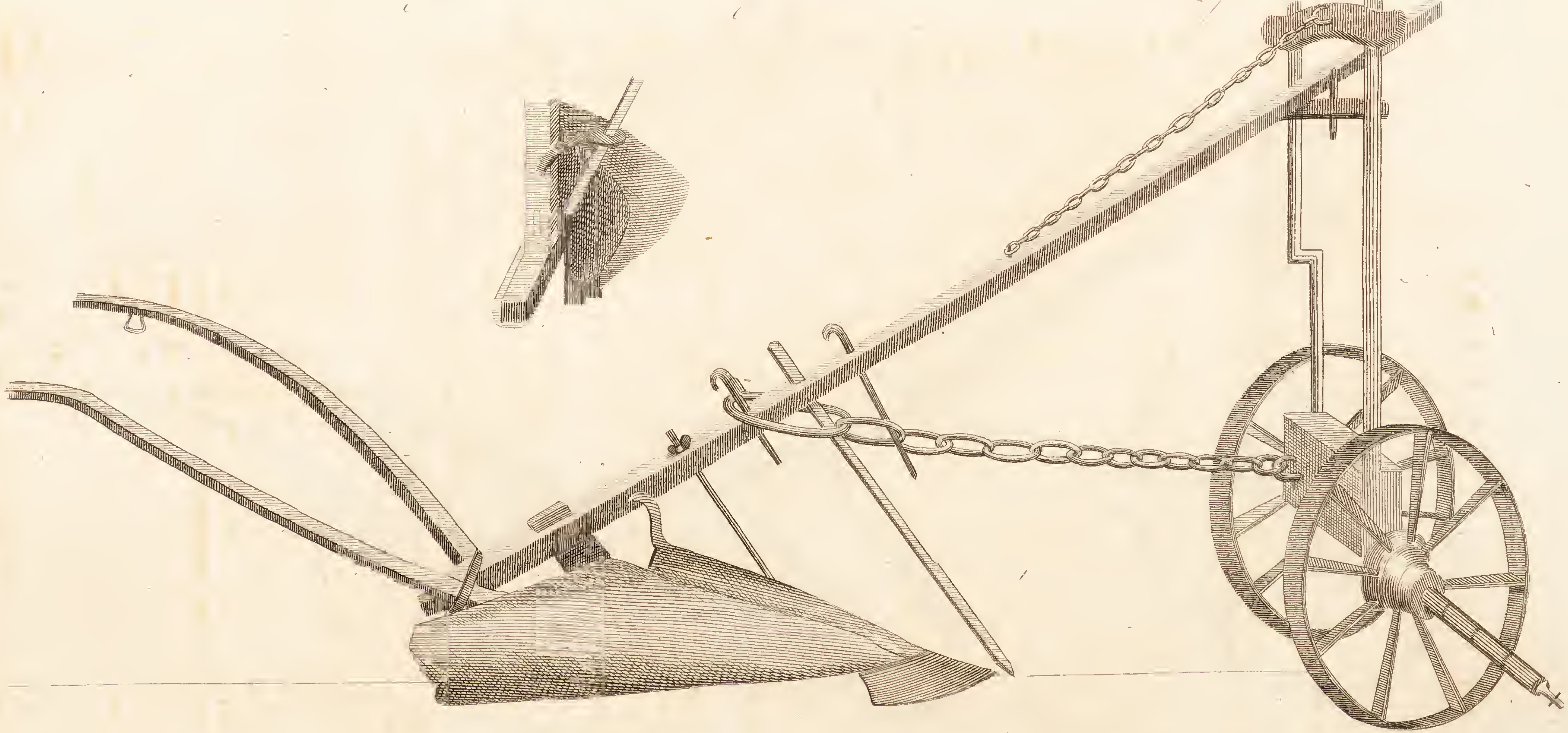
And in plate VIII. is shown a *Marsh plough* with a wheel coulter, used in Essex, by Mr. Gilbee, on light marsh land.

	Ft.	In.
From 1 to 2	7	0
1 to 3	4	0
1 to 14	1	4

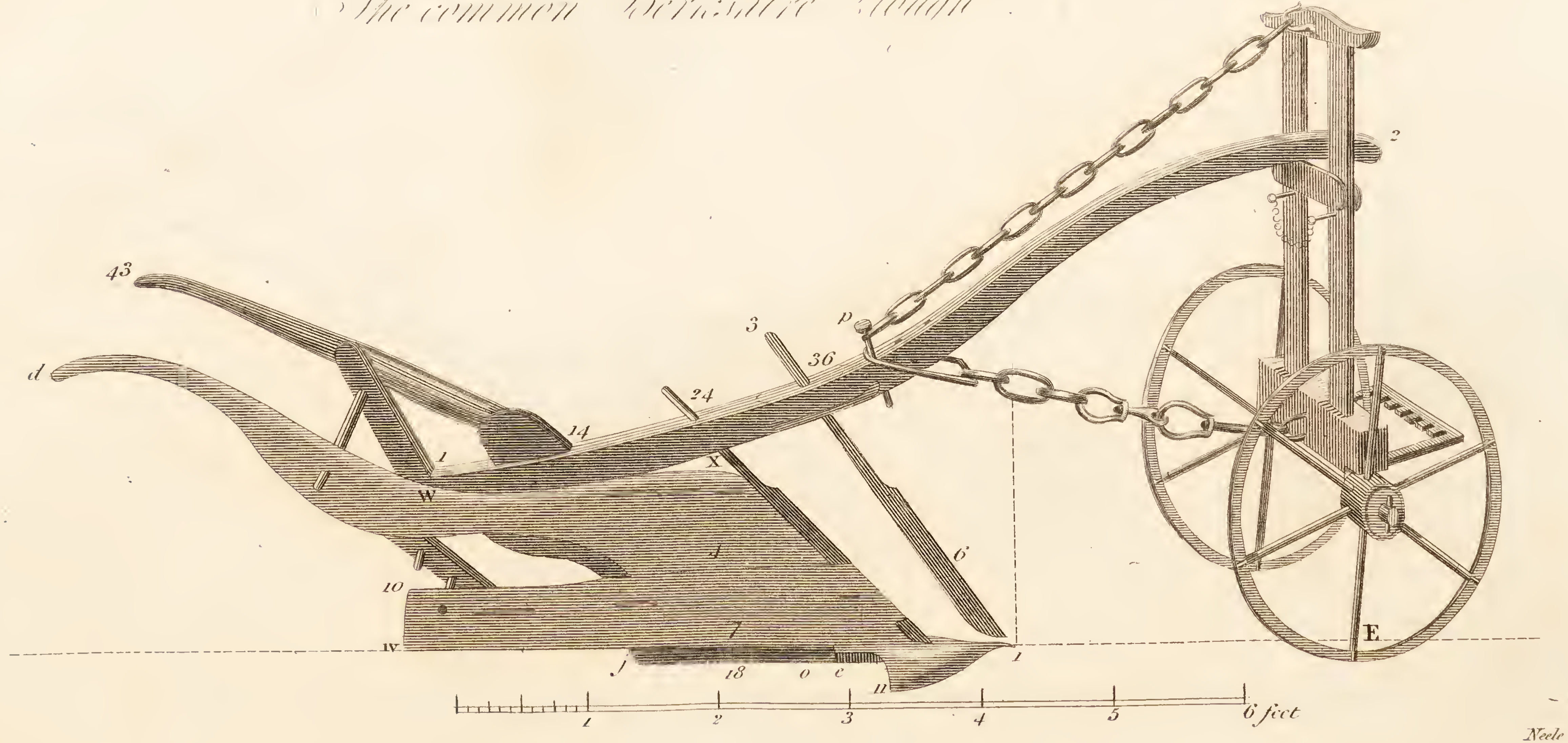
	Ft.	In.
From 2 to 15	1	11
1 to 4	3	3
4 to 7	1	2

Plate VI.

Common Essex Wheel-Plough at C. C. Western's Esq.

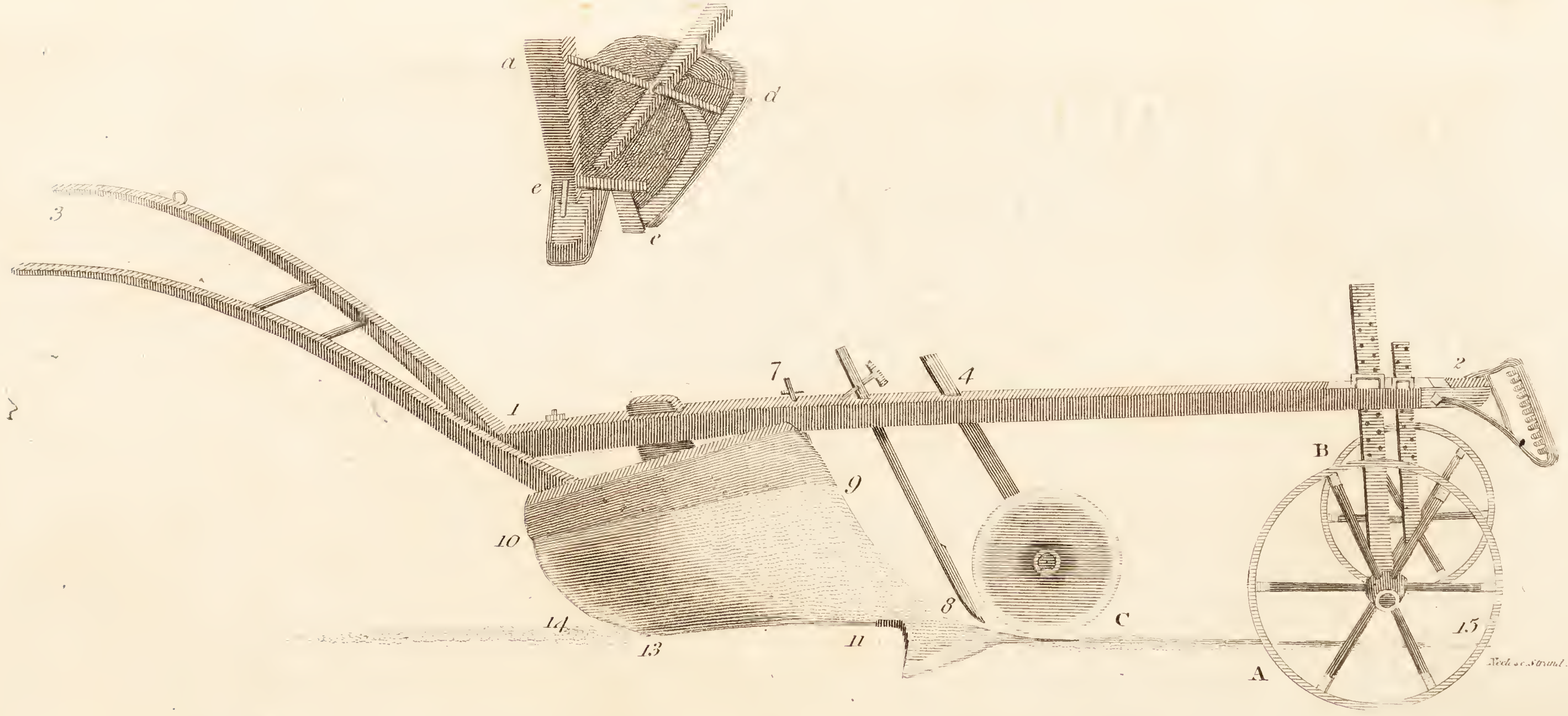


The common Berkshire Plough.



Neele sc.

PL. VIII.



Mr. Gilbees Plough at Grays with wheel coulter for Marshy land.

	Ft.	In.		Ft.	In.
From 4 to 8	1	8	Diameter A	2	0
8 to 9	1	0	B	1	5
9 to 11	1	0	C	1	1
9 to 10	2	2	d d	1	7
8 to 13	2	6	e e	0	9

The *double* or *two furrow plough* is an implement that has not yet, perhaps, been fully tried in all the different kinds of soil; but which certainly, when well made, may, in many sorts of land, be advantageously employed. It produces two furrows at once, and in some of the lighter sorts of soil has been found to perform its work in a neat and exact manner. It requires, however, of course, greater power in the draught, especially in strong soils when dry and stony, and does not in some of these cases answer so well. But for ploughing level sandy lands into wide ridges, it may, in general, be a good tool, though perhaps a little more confined in its work than a single plough. This sort of plough is considered by the inventor as well "adapted to all light soils and loams, whether of unequal or level surface." The chief and most important advantages attending its use are, in the saving of the attendance of one person, and in doing double the work in the same length of time, with less strength in the team.

This, which was at first disputed, seems clearly to be the case from the practical trials of Mr. Tweed, as stated in his letter to Lord Somerville, in which he says—"In answer to the letter I have just had the honour to receive, I take the liberty of stating the experiments I have made with your two-furrow ploughs upon strong land, as well as the result of the only match I have yet been engaged in. I put my first plough to work with three horses and one man, against two of my own, and four horses, held by two remarkably good ploughmen, who are very much averse to any new implements: after exerting themselves to the utmost every day for a month, upon clover lays, bean and pea etches, for wheat, they allowed, very much against their inclinations, that it performed the work best; which is entirely owing to the superior form of the breast, and the great advantage derived from the moveable plates. This trial having perfectly convinced me that there is an absolute saving of five shillings a day every day they are used, I ordered a second, and soon after a third, and have ever since had all my work done with them, nine horses, and three men, which before employed six ploughs, twelve horses, and six men; causing a reduction of one fourth the horses, and one third of the men; and is, in my opinion, one of the greatest improvements that ever was made in agriculture; for which I conceive the public and myself highly indebted to your Lordship. Being at Mr. Lovibond's rent dinner (the gentleman I live under), I made a proposal to the company, who were all farmers, to plough for a wager, two acres of any land with the two-furrow plough and three horses, as well, and in the same time, as one acre could be ploughed by a single one and two horses. This was accepted by Mr. Gibling, of Hatfield, and a field of his fixed upon that had been sown with rye directly after harvest, upon a wheat

etch, and being fed by bullocks and sheep in wet weather, poached a great deal; and when the ploughing took place, was extremely dry and bound. A great number of spectators attended: at starting, the odds were three and four to one against the two-furrow plough, as it was supposed not to be able to break up and turn hard work: after a fair contest, five farmers were appointed umpires, who were unanimous in their decision, that the two-furrow plough, having executed the work soundest and best, and in the least time, was entitled to the wager."

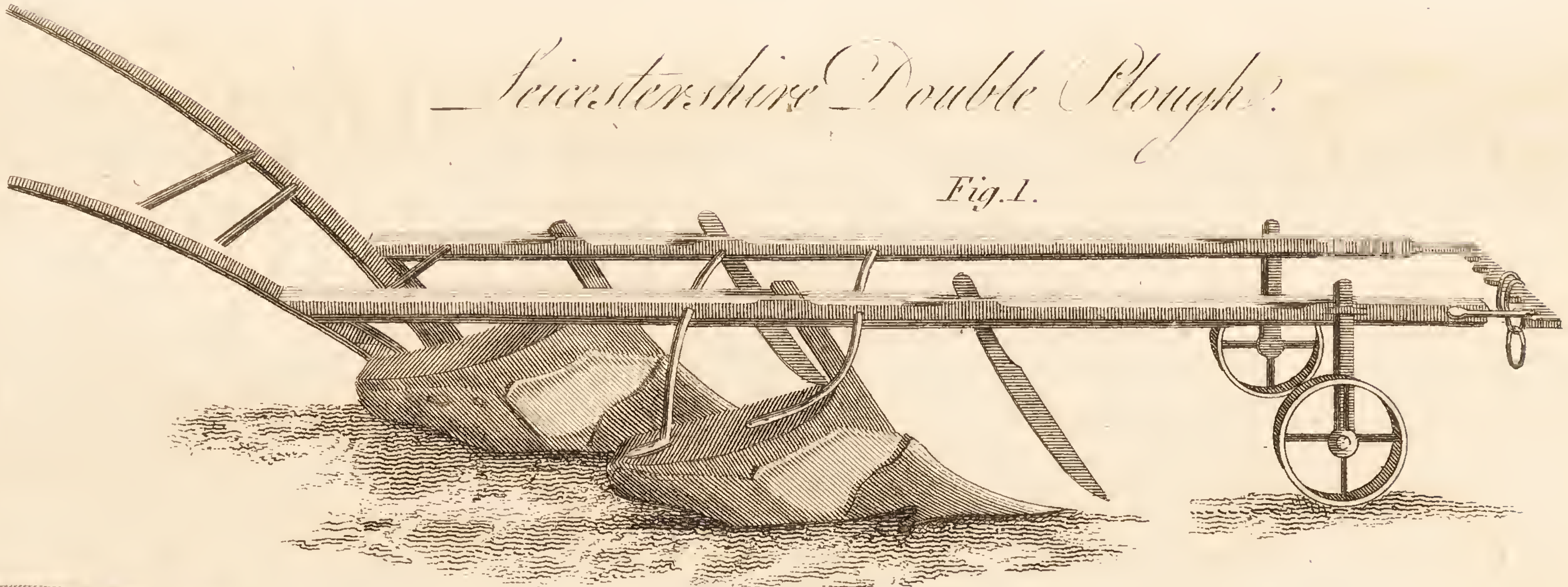
In other trials they have likewise been found to have a superiority, not only in performing the work in a better manner, but in considerably less time.

Ploughs of this kind are made either with or without wheels. It is, however, observed by the inventor or improver of them, that those which he has contrived, from the clean sharpened construction of the breast and throat, will be enabled to break up deep stiff land with infinite success; in which case the coulters should, he says, be set nearly straight with the throat and shares; but that in cross-ploughing, or stirring, they may be set three-fourths of an inch towards the land, by which greater dispatch may be obtained in seed-time. Should they carry too deep a furrow, the correction of their shares, he observes, is obvious; but if they hug too much to the land, or go unsteady to the ploughman, it must proceed from a want of setting them true relatively to each other, and from an undue regulation of the cops, as in this a nice attention is required. It may suggest itself, he further remarks, that two-furrow ploughs are unfit for hilly ground; but he thinks the very reverse is the case. The effect, he says, of ploughing across the inclined plain or hill, is that of carrying the soil in time to the bottom of the field, which must be carried bodily up again at a great expense: let such land, says he, be therefore worked from top to bottom; one furrow being carried with the hindmost or land share up the hill, and two down, so that the power may be apportioned to the weight with which it has to contend, and the needless toil to the team be saved. That power which was required to carry two furrows up, would be superfluous in carrying the same down the hill; and the effect will be as three to four, or an acre and a half instead of two acres in a day. And as deep ploughing is not much required, except where the cultivation of tap-rooted plants is intended, he thinks that two-furrow ploughs, though they should be deemed incapable of carrying a deep furrow, which, he contends, is far from the truth, must come into admirable effect, as a two fold advantage can be taken of the season in sowing, and the business being done at half the expense. But where long usage, and the convenience of constant road, confine persons to teams of heavy corn-eating cart horses, these ploughs become objects of great importance; becauses their teams will not, he conceives, feel the difference between their common single-furrow working one acre, and the well-constructed two-furrow plough with two acres a-day. It is remarked in addition to this, that some of the midland counties, as Leicester and Stafford, have been greatly benefitted, under these circumstances, by the use of

Pl. IX.
P. 25.

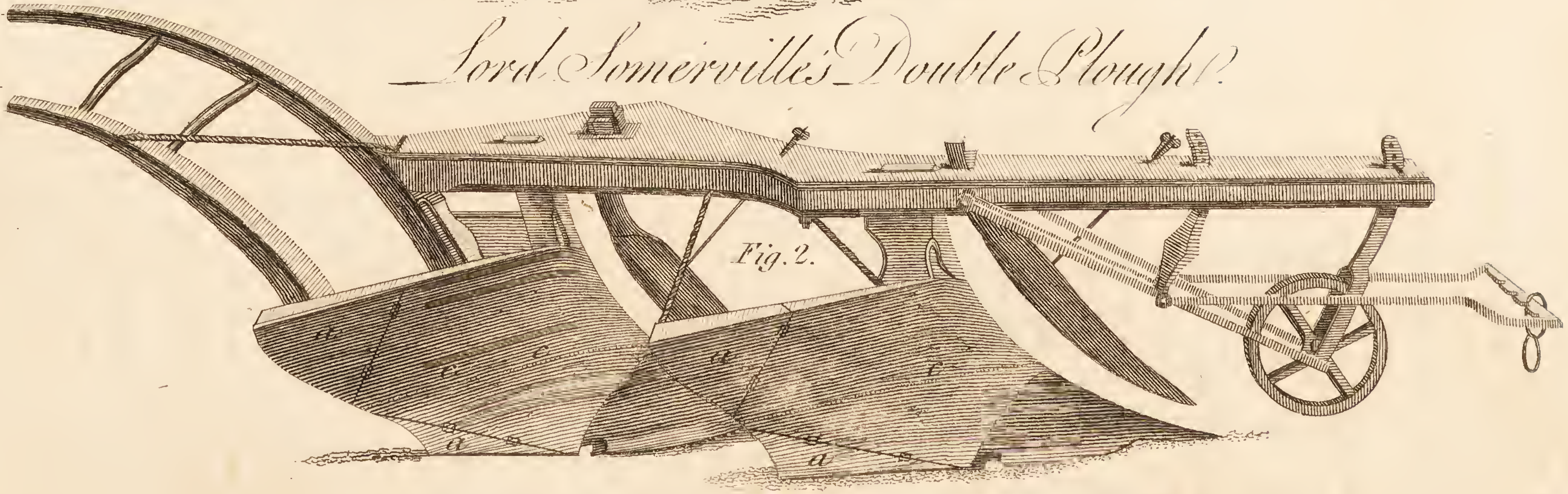
Leicestershire Double Plough.

Fig. 1.



Lord Somerville's Double Plough.

Fig. 2.



these ploughs, although they have not been so constructed in the throat and breast as to lessen the means of resistance. And obtusity in these parts not only adds incalculably to the weight, but is liable to break the furrow, and thus spoil the work. It may likewise be observed, that removing resistance not only removes the labour of the cattle, but is equally advantageous in increasing the strength of the implement.

It is still further remarked, that this sort of plough has lately been found useful in his own country, in even breaking up ley-ground, although formerly only in common use for fallowing, not being thought capable of ploughing leys, as, from their construction, requiring too great strength in the team; and that a premium has lately been given for this sort of plough, working ley-ground only. He states also, that one acre and a half of ley-ground was broken up by four oxen with great ease to themselves in three hours and fifty-five minutes, they having, as part of a constant course of work, ploughed seventeen perches short of an acre of the same kind of ground the same morning: this was performed in order, he says, *to prove the effect of moveable plates at the extremities of the mould-board*, that the furrows might be laid more or less flat; as mould-boards formed to lay furrows in lay, so as to give the greatest quantity of mould or soil to harrows, cannot be of that shape or form best suited to make good work in stirring earths, more especially the last, which ought to be thrown up in small seams, as it were, that the seed may be properly buried. For this purpose it has, he asserts, hitherto been usual to rip off the plate and drive in wedges, by which the mould-plate must be liable to be injured; and from the trouble attending the operation, it has often been omitted, and consequently the land imperfectly worked. This inconvenience may, he says, be remedied, and the mould-board be adjusted with great facility and expedition, by having the necessary parts of the mould-board or plate cut off, and afterwards connected with the fixed parts of it by means of flat hinges, or of thin flexible plates of tempered steel, or of hard hammered iron, so as to admit of these parts being set to have different inclinations with the fixed part of the mould-board. By means of two screws passing from the inside through the lower parts of the handle of the plough, opposite the back parts of these moveable pieces, they may be kept at any desired degree of inclination, according to the nature of the work to be performed. As ley-grounds cannot be laid too flat, or seed-earths too much on an edge; by this improvement in the mould-board of these ploughs he thinks it may be readily adjusted for either purpose, as it may be rendered more flat or more convex, according to the circumstances of the case. In short, the principle of these plates is, that of depositing the furrow at any angle that may be required, and by that means rendering the ploughs proper for different purposes in tillage-husbandry.

The increased weight of draught when these moveable plates were extended, did not appear, he observes, on trial, in a two-furrow plough, to be, by the cops, more than twelve pounds, in ley-grounds at six inches depth. The friction in furrows required to

be laid flat was, it is said, less than could have been supposed, probably in both furrows not more than from twelve to six pounds.

It is remarked by the same author, in another work, that in order to qualify ploughs of this kind for broad work of every description, breaking up of leys not excepted, these plates are absolutely requisite; and that in single ploughs they are almost equally so. The principle of this moveable plate, says he, though it may not at first catch the attention of every one, has found stout advocates in ploughmen, as it saves their right arm much trouble in wedging and hammering mould-plates, and their right leg much exertion in attempting to tread flat the furrow which the plough had left on an edge. It is likewise suggested that in many cases the moveable mould-plates may probably supersede the use of the turn-wrest plough.

The inventor has since improved these moveable mould-plates, and designed them so as to suit single-furrow ploughs of every kind; having taken out a patent for the purpose of securing them.

In respect to the construction of double ploughs, it has, Lord Somerville observes, "been argued, that a two-furrow plough, with the double-mortised beam, has an advantage over that of the curved single beam, inasmuch as, by a screw, the beams can be brought nearer or set more apart, for the purpose of cutting a wider or narrower furrow. In common ploughing, no great benefit was, he says, contended to result from this power, but in sowing under furrow great things were to be expected. Now let us look round, and see, where the tillage-husbandry is reputed to be good, and single-furrow ploughs in use, consequently, the size of the furrow is optional; let us see, he says, whether the wide or the narrow furrow is preferred. We can in a moment instance the usage of the country round Westham, in Essex, and Petersham and Moulsey, in Surrey. In both instances the land is level and good, and the broadcast husbandry very high in reputation, as their crops, on an average of years, are ready to testify. Here the seed is ploughed in at a ten, or sometimes at an eleven-inch furrow. We are not to establish a general system on two or three instances—twenty or thirty might, perhaps, be adduced; but they are worth, he thinks, at least one assertion." Though determined, "to avoid, as much as possible, any comparison of other implements with his own;" he thinks he may say, that he learns "from one who is as good a judge of husbandry as any among us, and has compared the double-beam two-furrow, with that of the curved single-beam two-furrow plough, that besides additional expense in mortising and iron work, and consequent tendency to derangement, there is an absolute difference of one horse in four in favour of the patent plough."

In ploughing, it is added that when land "is inclined to be wet and stiff, the less trod it is the better. Here Mr. Tweed's mode is," his Lordship says, "to work three horses, one on the land, and two in the furrow one before the other, instead of three abreast: and it appeared by the regulation of the cops, that is, an iron screw acting through the beam to regulate the depth of work, how little

he has added to the weight of draught. It is almost needless, he thinks, to say, that the true point of draught should be exactly in the centre notch of the cops; any deviation to the right or left can only be for the purpose of counteracting a false friction or pressure, which must have added to the weight. The size of a furrow, provided it be of just proportions, is optional; that which he has preferred is nine inches and a quarter, and for every purpose of husbandry he knows of none better. It will give as much mould, or *crumb*, to the harrow, as any other furrow whatever: this is the best object in ploughing for a ley crop.

" If, " says he," ley peas are to be sown, every other furrow at nine inches and a quarter each, there will be an interval of eighteen inches and a half between the rows; a distance as much approved as any we know. At every third furrow for beans, the interval will be twenty-seven inches three quarters; at every fourth furrow, thirty-seven inches: and it must be allowed, that if any implement be attached to a plough for delivery of pulse, or white grain in drills, the upright position necessarily belonging to the two-furrow plough, when in work, will qualify it admirably for this purpose."

Where, however, the circumstances of the land are such that they can be introduced with any probability of advantage, they ought not to be overlooked, as being conducive, by their great dispatch of work, to œconomy in farming labour; which is certainly an object of much importance.

Ploughs of this sort have, as just shown, been constructed in different methods. At fig. 1. in plate IX. is exhibited a *double plough* employed in Leicestershire; which requires a pretty strong team, but is capable of ploughing two acres a-day, going steady without holding from one end of the furrow to the other. It is made by Mr. Handford of Hathern in the same county, and costs about *5l. 5s.*: and at fig. 2. in the same plate, is a representation of Lord Somerville's two-furrow wheel plough, mentioned above, in which *a a* is the moveable parts of the mould boards attached to the fixed parts by means of flat hinges, thin flexible plates of tempered steel or hard hammered iron, so as to admit of being set to form different inclinations with them. This is effected by means of screws passing from the inside behind these moveable parts, but which are not seen in the figure. These screws are so contrived as to keep the moveable pieces in any position, according to the nature of the work, so as to lay the furrow-slice more or less flat. The parts of the mould-plates marked with the dotted lines *c c*, as most liable to wear, should be twice the thickness of the others, in order to last as long as the rest of the plough.

Mr. Hillier of Oxfordshire has lately invented a *double plough*, in which the draught is very low, and by a chain from the hinder part of it.

Skim coulter-ploughs are a sort of ploughs that may often be employed with advantage on extensive farms, where there are such kinds of lands as require them. Of ploughs, somewhat of this nature, there are many different sorts adapted to particular uses and situations; such as the *trench-skim-plough*, which is simple in its princi-

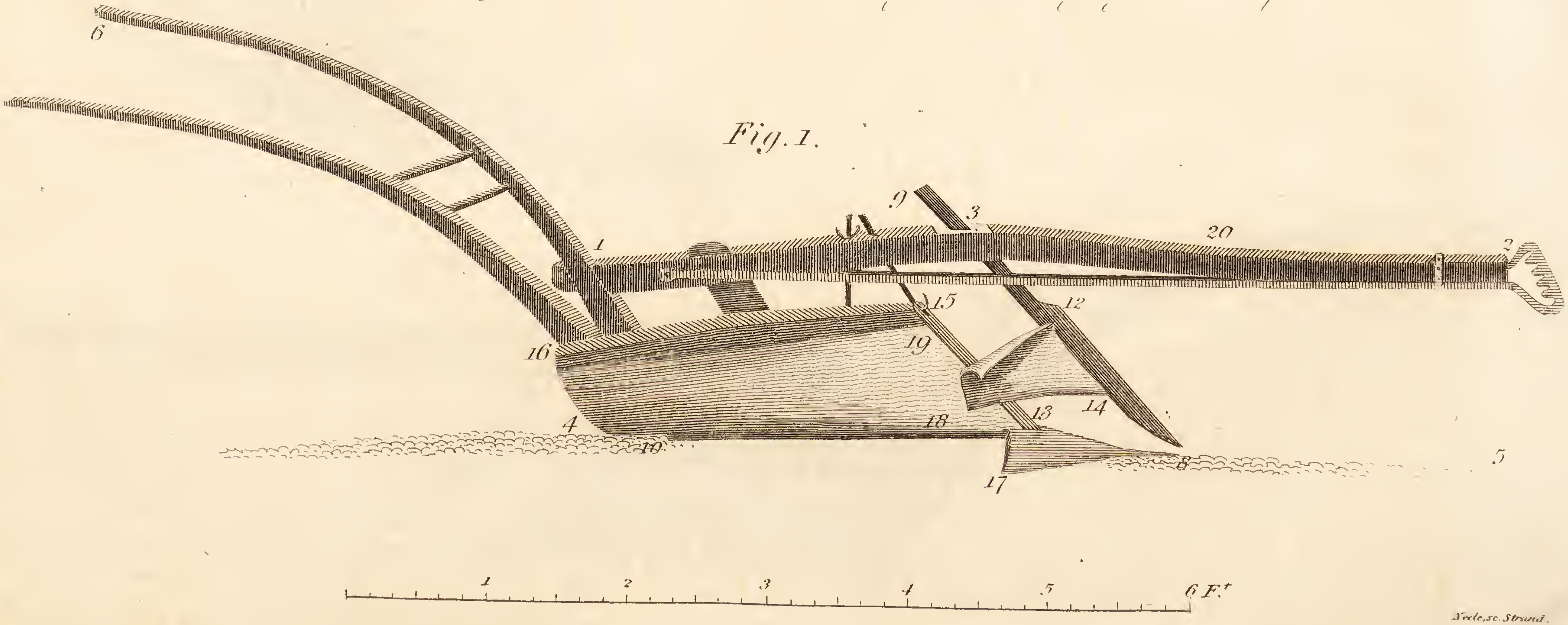
ple, being so contrived as to open up the ground to a great depth, in soils of different kinds, where there is sufficient staple. It is an exceedingly useful implement in various cases, as by means of it land may be opened to any depth in separate horizontal slices, the weeds being thus cut off in the first operation, while the next raises a slice or portion of fresh mould from below the soil which afforded the former crop, and deposits it upon the rubbish before turned down, by which means more abundant nourishment is prepared for the crop that is to follow. For these purposes, however, in all soils, a strong team must be had; but only one such tillage is required for most crops. From the slices of earth raised by this plough being placed one over another, the ground generally harrows well, and the growth of weeds is in a great measure prevented.

It is consequently evident, that, considering the number of ploughings generally given in the ordinary way of preparing lands for a crop of barley or turnips, and under the following system for wheat, and the labour and expense in the latter case, of raking, picking, and burning weeds, that the advantages of the trench-skim plough must be greater than is, perhaps, generally supposed. There is also another consideration of some importance in this system of management, which is, that the staple of the soil is increased in depth, and its parts so divided and loosened that the fibres of the roots of the crop are more at liberty to range, and of course to take up their proper nourishment; which must render it more certain, and of better quality. In this plough, Lord Somerville observes, "the skim requires a perpendicular direction, and the coulter-hole to be further removed from the throat and share;" as "in the common position it would choke when in work." A plough of this kind with a double share, one placed directly over the other, has been much employed by some good cultivators in the southern parts of the kingdom. By this means, one narrow shallow furrow may be taken off the surface, and another beneath it any moderate depth that may be required; and it will perform its business to ten inches in depth, as well as only five or six. It is a highly useful tool in putting in one crop immediately after another; a mode of cultivation which could not indeed be well practised without it. In this way rye, or other green crops which have great height of stem, may be turned down without leaving any part of them sticking out in the seams or crevices between the furrows; whatever is turned in being really covered; by which means the surface is of course perfectly free from weeds, and clean for the succeeding crop, of whatever kind it may be. The skim-coultered plough, invented by Mr. Ducket, is considered by those who have had much experience of it as one of the best implements of this nature ever invented, being the most effective. It is applicable to many different purposes, but particularly that of breaking up old grass-lands; as it is well known that, where this is performed by a common plough, there are between the different furrows mostly seams of grass, which continue to vegetate during the summer season, and greatly injure the crop. But this is entirely prevented by the use of this implement, which is capable of being employed in all cases, except where there are roots or stones on the surface that

Plate X

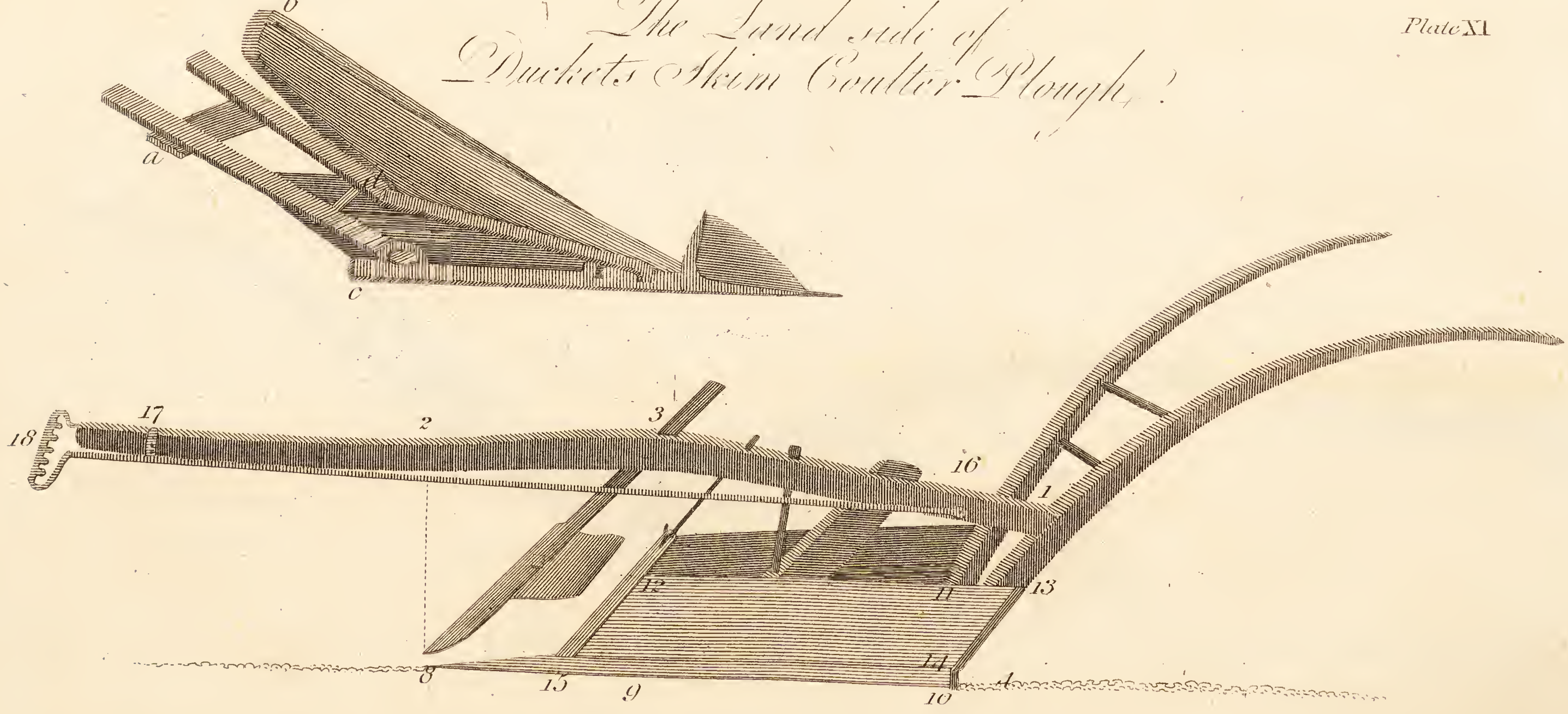
A Plough by Ducket at Montagu Burgoyne's Esq.

Fig. 1.



Neele, sc. Strand.

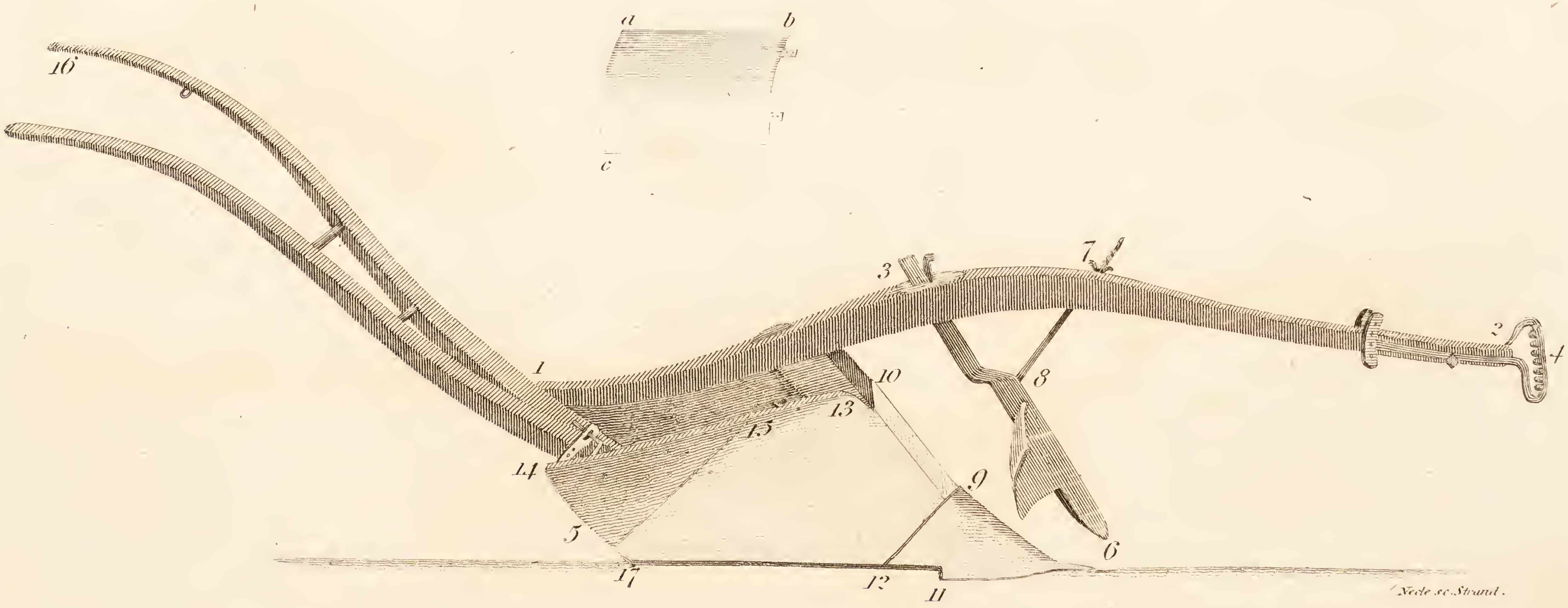
The Land side of
Duckets Skim Coulter Plough.



Neele, sc. Strand.

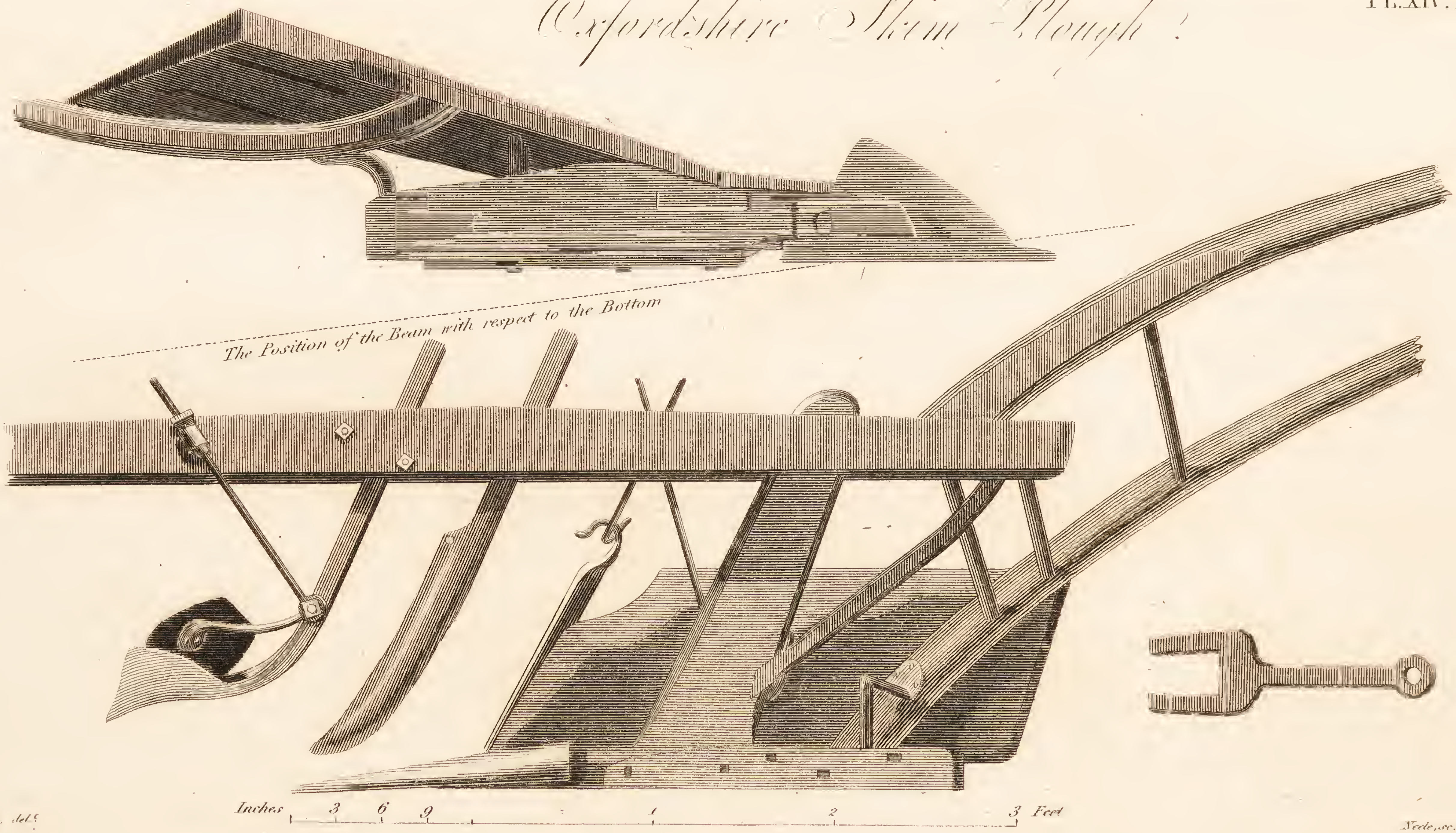
Plate XII.

Mr. Warren's Skim Plough with moveable Breast.



Neele sc. Strand.

Oxfordshire Skim Plough.

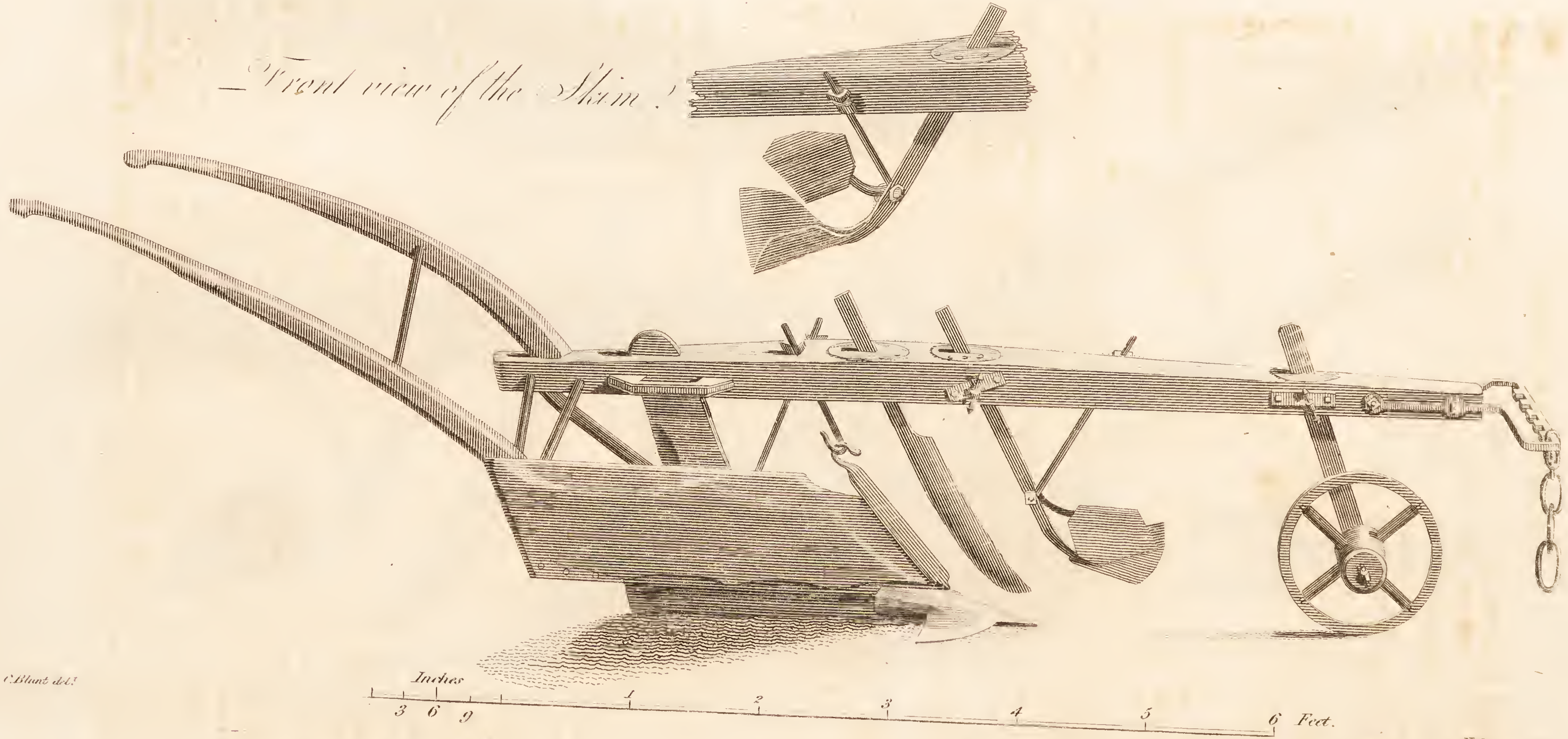


C. Blunt, delt.

Neele, sc. Strand.

The Oxfordshire Skim Plough.

PL. XIII.



C. Blunt del.

Neele sc. Strand.

obstruct its operation. At fig. 1. in plate V. is a *single-wheeled skim-coultered plough*, which is capable of being used also with the common, without the skim-coulter, and costs about 3*l.* 13*s.* 6*d.*

In plate X. is represented a *skim-coulter plough* by Ducket which is in use at M. Burgoyne's, in Essex.

			Ft.	*In.*				*Ft.*	*In.*				*Ft.*	*In.*
From	1	to 2	6	6	From	8	10	3	3	From	18	19	0	9
	1	3	2	8		1	12	1	2		3	20	1	6
	1	4	1	5		12	8	1	1		20	8	1	6
	2	5	1	7		13	14	0	4		a	b	0	14
	1	6	3	8		13	15	1	4		o	d		7
	6	7	3	0		15	16	2	9					
	3	8	2	3		16	14	2	7	Coulter 3 inches broad.				
	8	9	2	10		8	17	1	1					

A land side view of Mr. Ducket's *skim-coulter plough* is given in Plate XI.

In Plate XII. is a representation of a *skim-coulter plough* on another principle. It has a strengthened coulter, and a moveable breast on Lord Somerville's plan. It is in use on Mr. Warren's farm in Essex.

			Ft.	*In.*				*Ft.*	*In.*				*Ft.*	*In.*
From	1	to 2	5	9	From	3	6	1	11	From	6	12	1	3
	1	3	2	2		3	9	0	9		12	17	1	2
	2	4	1	4		9	10	0	9		12	33	1	0
	1	5	1	0		9	6	0	11		13	14	2	0
	3	7	1	1		11	6	0	11		14	15	1	2
	7	6	1	9		11	9	0	8		1	16	3	9

In Plate XIII. is shown the Oxfordshire *skim plough* with a front view of the skim. And in Plate XIV. a land side view of the same.

The *miner* is a sort of plough which is used for opening ground to a great depth : it is made very strong, but with a share only, not having any mould-board ; it therefore rather opens or loosens than turns up the earth. In deep stiff soils, where the surface mould is good, it may be conveniently employed in the same furrow after a common plough, in order to stir the ground to a greater depth. It is in use in some of the northern counties ; and Doctor Anderson mentions it as an implement that all farmers who have land suitable for it should have in their possession. It is an extremely useful tool where working deep is necessary without bringing up the inert under-stratum or sub-soil ; as in loosening the ground for carrots, or other tap-rooted plants, and in eradicating the roots of thistles or other weeds which strike deep in the earth.

The *paring plough* is a necessary instrument where the practice of paring and burning is much required ; as in bringing into cultivation heath, moor, and other waste lands. It is constructed in such a manner that the surface of the ground can be cut off to any depth ; which is an advantage that can scarcely be obtained by any other means. A plough of this nature, calculated for course rough lands, which was in use at Sheffield Place, the seat of the right honourable

Lord Sheffield, more than thirty years ago, having been procured from Cheshire, where it had been employed on the farm of Sir George Warren, will be represented in speaking of paring and burning.

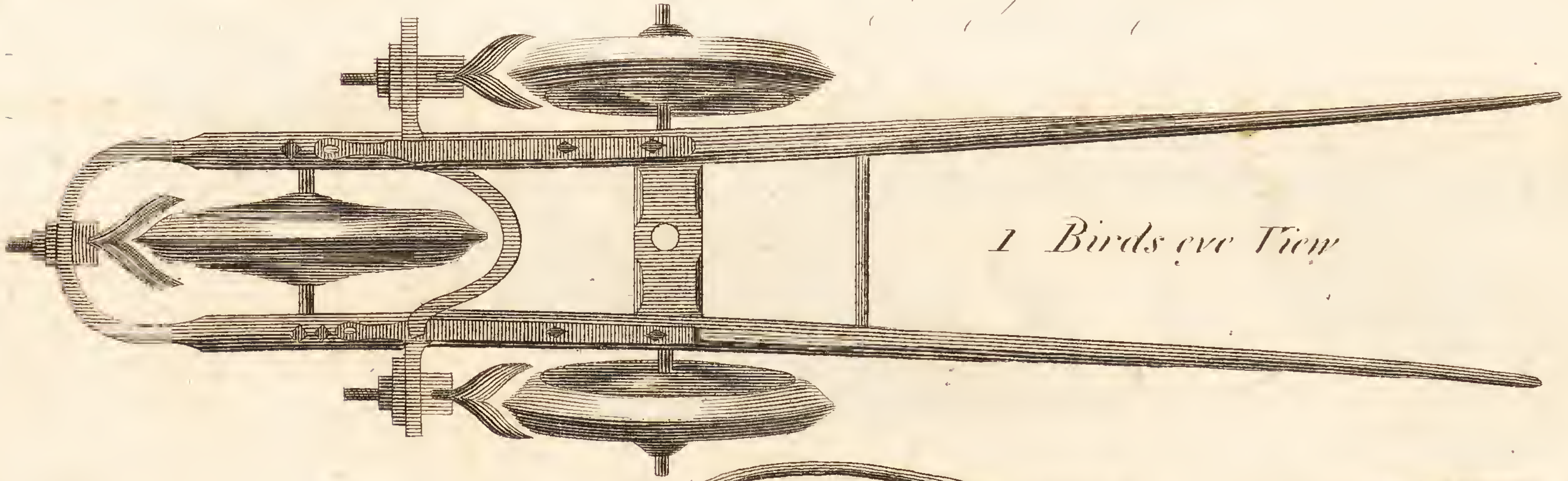
Besides the ploughs already described there are still some others invented for particular purposes. Mr. Lambert has constructed, what he terms, a *revolving plough*, which is capable of performing its work all one way. It is represented in the Oxfordshire Agricultural Survey, lately published. And Mr. Berriman, of Berkshire, has contrived a tool which he terms a *pressing plough*, which is intended to be passed over land already ploughed, in order to render it free from hollows, and even for the reception of the seed, which may then be sown broad-cast, and by rolling it into the channels of the pressing wheels, it will be evenly and equally buried at a proper depth, and after harrowing be better preserved from birds, and come up more regularly. In fact, it is supposed to combine the advantages of the drill and broad-cast systems. At fig. 1. in plate XV. is a bird's-eye view of this plough; and at fig. 2. it is displayed in its action as a drill, as well as a pressing plough.

Draining-ploughs. In the surface-draining of land, different sorts of ploughs are in use in different places, according to the difference of the soils, and the objects of the farmer.

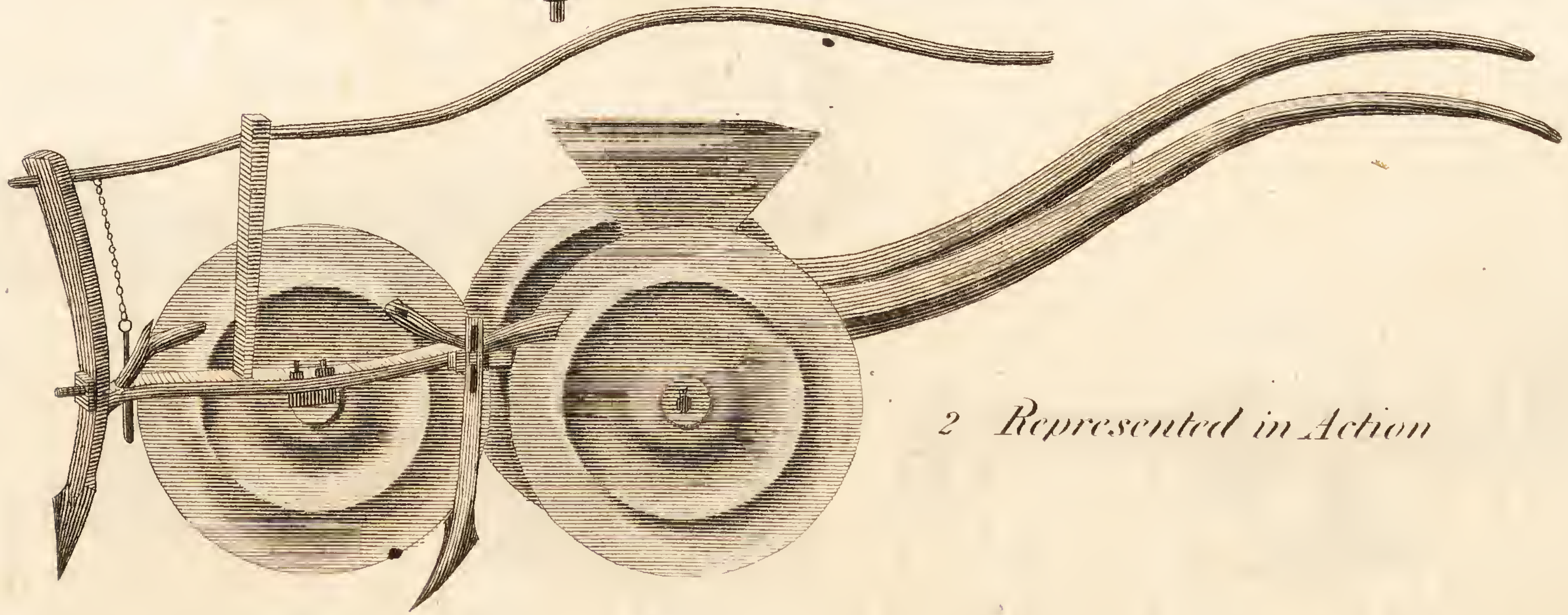
The *common draining plough*, employed in some of the midland counties for the general purposes, is a good, cheap, well-known tool. At fig. 1. plate XVI. is the representation of a *drain* or *gutter plough*, recommended by the Duke of Bridgewater; in which *a b* is the beam; *c d* the handles; *e* the share or sock; *f* the coulter, or first cutter of the sod, fixed to the share; *g* the other coulter, or second cutter, which separates the sod from the land, and directs it through the space or opening between *f* and *g*, this coulter is connected with the share and beam; *h i* the sheath; *k* the bridle, or muzzle to which the swingle-tree is attached; *l m* two wheels of cast iron, which may be raised, or lowered by screws at *n* pressing upon the flat irons *o o*, to which the axis of each wheel is fixed. These wheels regulate the depth which the share is to penetrate into the earth; *p* a chain with an iron pin to move the screws at *o*. It has been found useful in forming gutter-drains on grass land where the soils are of a retentive nature. The power of six horses is required in drawing it in soils that have not been drained before; but in opening the old gutters four horses are sufficient.

The *common mole plough*, invented by Mr. Adam Scott, as improved and made use of in the midland counties, is likewise an implement of this kind, which in suitable soils and situations, as in pleasure-grounds, and where much regard is had to the surface-appearance of the land, may be of considerable benefit in forming temporary drains. It makes a drain without opening the surface any more than merely for the passage of a thin coulter, the mark of which soon disappears. This instrument is chiefly employed in such grsss lands as have a declination of surface, and where there are not many obstructions to contend with; but it may be used in

Mr. Berriman's Crossing Plough



1 Birds eye View



2 Represented in Action

Neele sc.

Draining Ploughs.

PL.XVI.
Page. 26.

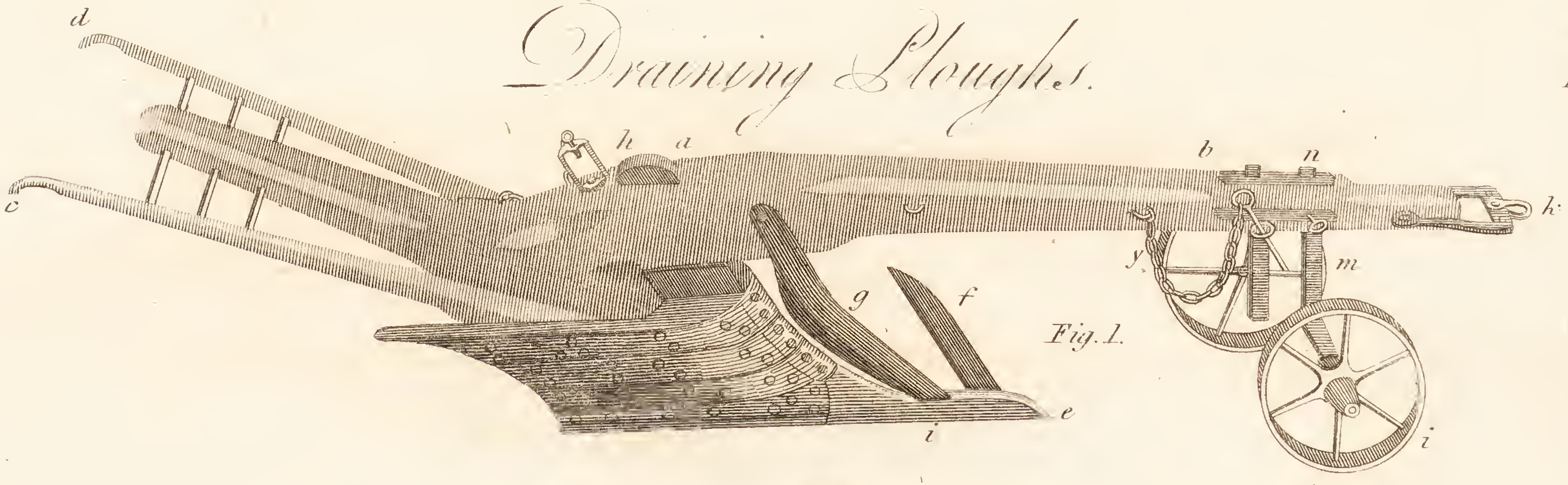


Fig. 1.

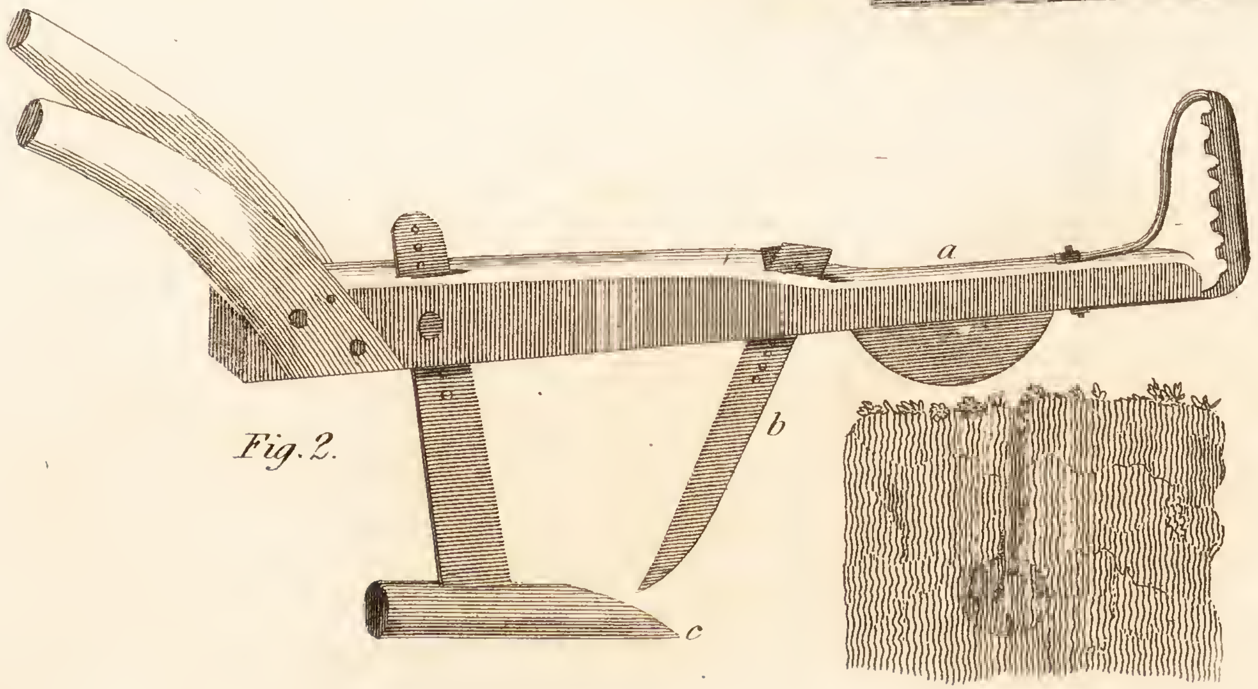


Fig. 2.

Fig. 3.

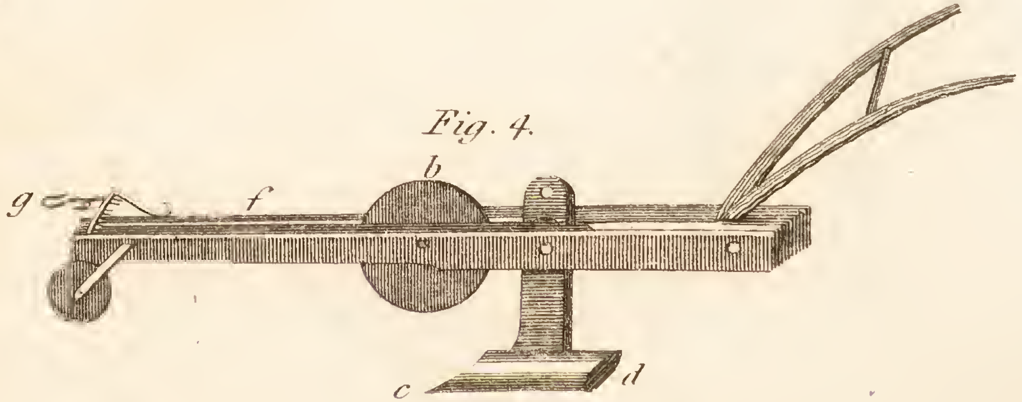


Fig. 4.

Mr. Emerson's Draining Plough.

Fig. 1.

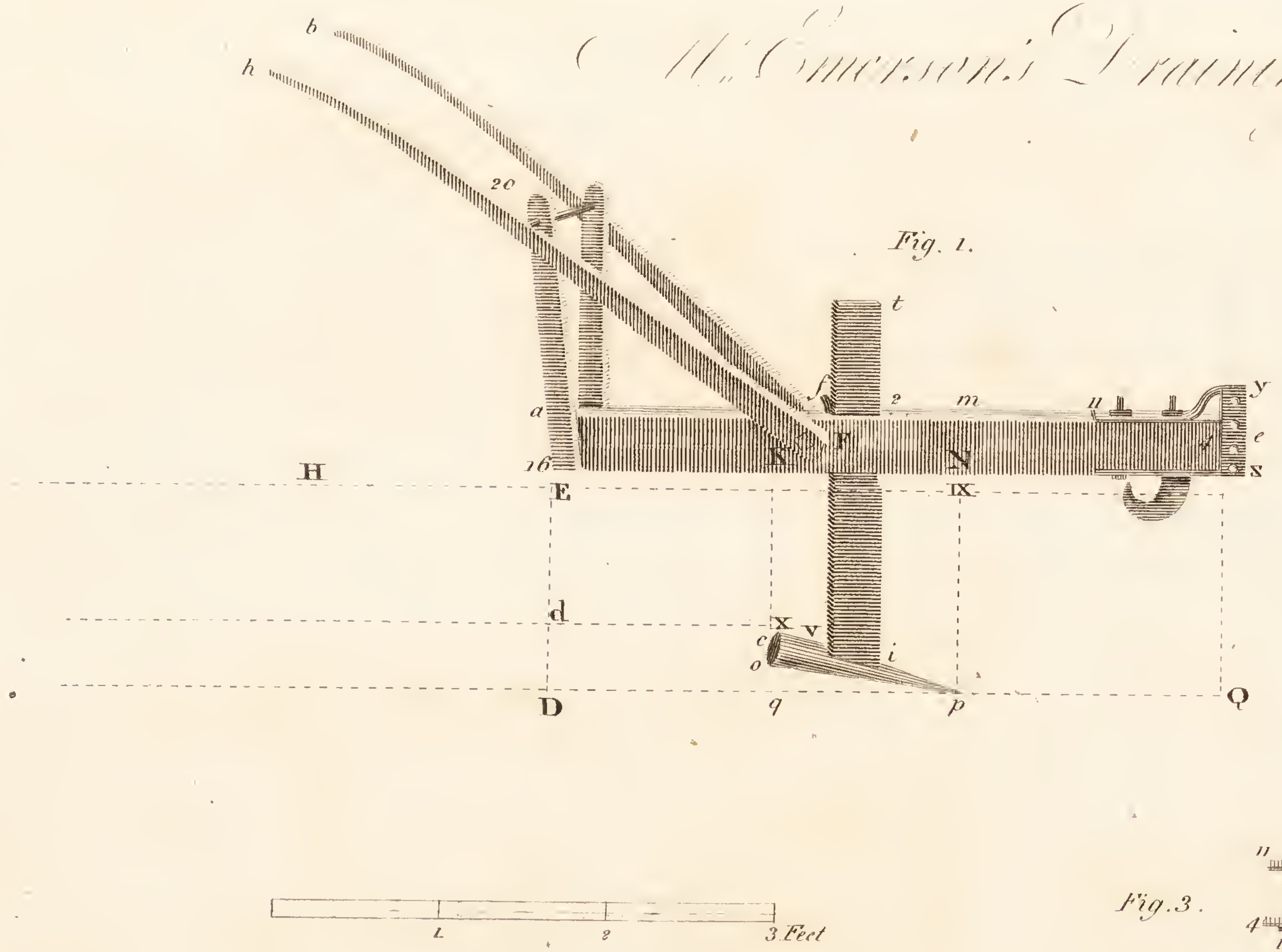


Fig. 2.

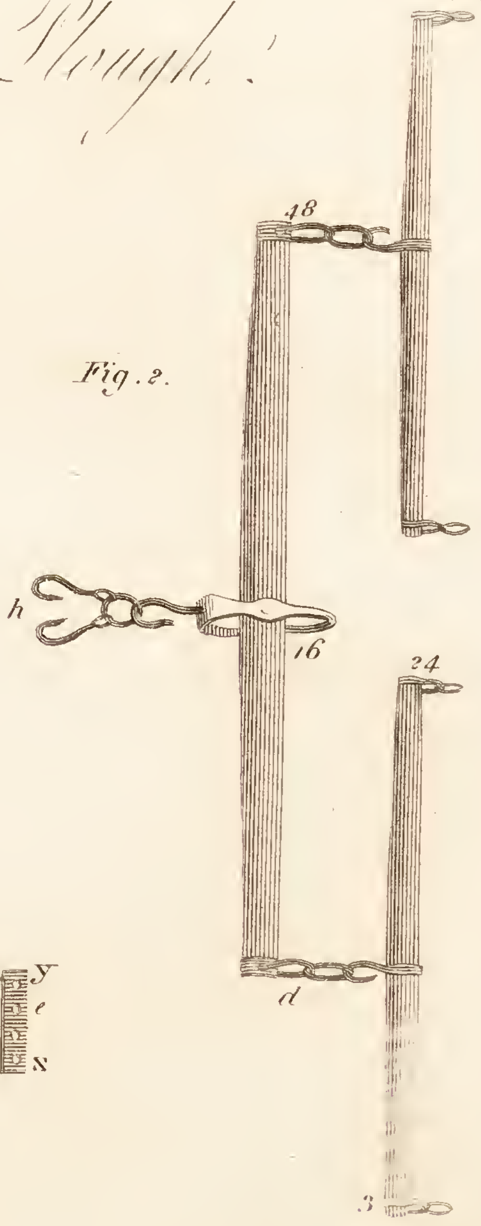
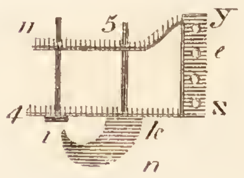


Fig. 3.



other kinds of land, as on turnip grounds that are too wet for the sheep to feed them off, or where, on account of the wetness, the seed cannot be put into the earth. With this plough the drains should be made at the distance of ten or fifteen feet in straight lines, and all so contrived as to discharge themselves into one large open furrow, or grip, at the bottom of the field. As it requires great strength to draw this implement, it can only be used where a good team is kept. It is suggested by a very intelligent practical agriculturist, that in deep clayey soils it may be highly useful, but that where there are beds of gravel or sand intervening it cannot be employed with advantage. An improved plough of this description is represented at fig. 2. in which *a* is the beam; *b* the coulter, and *c* the cone which forms the drain. It has been lately improved so as to require much less force of draught, by having wheels placed before, and a roller behind, but which are not shown in the figure. This is an effective implement on lands of the stiff clayey kind. And at fig. 3. is a section of the drain formed by the mole plough.

Another *plough* of this sort which is worked by women by means of windlasses, has been invented by Mr. Lumbert, and is said to answer perfectly in making the drains, besides the windlass parts of it being applicable to various other agricultural purposes. It has since been further improved, so as to be wrought by one horse attached at the end of a long laver.

A more full explanation of it will be given in speaking of its application in the practice of draining.

At fig. 4. in the same plate is also seen another plough for under-draining, in which *a* is a small roller for regulating the depth of the plough; *b* a rolling coulter to cut the turf or other coarse herbage on the surface. It may be taken out when used on arable land; *c* a flat share, edged in front; *d* bottom of share rounded above, oval at the bottom, and pointed to make an opening for the water; *e* pin head for regulating share, so as to form drains at different depths; *f* beam, which is strong and plated. It may also be wrought by attaching a pair of low wheels with the shafts, by a chain, to the hook *g*.

The *draining furrow plough* is another plough of this class, which may be employed for making large open furrows, by which the water may be taken off from the surface of the land. It will frequently be found a necessary tool in those clayey soils where water stagnates on the surface of the ground, and which cannot be removed by the more general modes of under draining.

In plate XVII. is a view of Mr. Emerson's *draining plough*, which is used in Oxfordshire. It is drawn by six horses double, as seen by the whipple-tree. The hooks *b* being put on at *e* fig. 1. the shortness of the draught is shown. The back of the coulter is half an inch in thickness. The inclination of the share is shown by *c p*.

Fig. 1.						Circumference.		
	Ft.	*In.*		*Ft.*	*In.*			
a 4,	4	0	2 m,	0	6		*Ft.*	*In.*
a F,	1	7	N 14,	0	2	x,	0	7
F h,	4	1	n p,	1	8½	v,	0	6½
b h,	1	11	14 XI.	1	1¼	i,	0	5
H h,	2	6	o p,	1	1¼	Fig. 2.		
16 20,	1	8	K q,	1	4	d 48,	4	0
a f,	1	8	N p,	1	4	32 4	3	6
a 2,	2	0	c K,	1	1	h 16	1	4
2 4,	2	0	p 14,	1	2	h 24,	2	0
4 c,	0	2	c xi,	0	11	Fig. 3.		
y z,	0	6¼	xv,	0	3¼			
e 1 1,	0	11	vi,	0	4¼	e 11	0	11
e a,	4	2	i p,	0	5½	e 5,	0	5
a D,	1	8½	o x,	0	2½	y z,	0	6¼
e Q,	1	8½	c p,	1	1¼	1 14,	0	4¼
a E,	0	6½	c q,	0	3	i k,	0	5
i t,	2	2	d D,	0	4 1/6	k z,	0	4
f 2,	0	4	E D,	1	2	k n,	0	4

They have also in Essex, a large strong draining plough which they use for cutting out the first spirt for hollow drains. It is drawn by six or eight horses, according to the soils, and operates to the depths of twelve inches. It is represented in the Survey of Essex.

Drill-Machines.—In the construction of all implements of this sort the greatest attention should be paid to have them as simple in their mechanism as possible, in order that they may be used without difficulty by those who have but little knowledge of the nature of such machinery: much care should also be taken to have them so made as that they may perform their work with correctness; that the seeds, of whatever kind, may be delivered and deposited in the ground with the greatest evenness and regularity; and that they may not be bruised or injured in any way during the operation; as the want of proper attention to these particulars seems to have considerably retarded the progress of the drill system of cultivation.

Various implements of this sort are in use in different parts of the island, which are contrived for the purpose of stirring the earth, and drilling different kinds of grain and seeds at the same time; but in the choice of such tools the farmer should be chiefly directed by the situation of his ground, the nature of the soil, and the kinds of grain which he intends to cultivate. In general, however, the more simple the construction of such instruments, the better they perform their work; one and the same sort of drill cannot, however, answer on farms of large and small extent; they should therefore be adapted to the size of the farm, as well as the nature of the soil and crop that is to be cultivated.

The machine which was proposed and made use of by the ingenious and intelligent improver of the drill husbandry seems to have been by no means well adapted to the purposes of the system,

and on that account probably contributed to retard the progress of the art. It neither sowed the seed in sufficient quantity, or with sufficient accuracy, though its general principle appears to have been sufficiently clear and simple, from its having become the model of many subsequent implements of the same kind. A late ingenious author has recommended many interesting and useful improvements in this machine, such as enlarging that part of the axle-tree which delivers the grain into a cylinder of some inches in diameter, with excavations in the rim, which rim rises above the corn in the seed-box, and lets drop again into the seed-box whatever grains fill the holes above the level of the rim, as that side of the cylinder ascends. By these ingenious contrivances the quantity of seed delivered is rendered uniform, and none of the grain is in the way of being crushed or otherwise injured. The whole machine thus becomes simple in its construction, and of no great expense; which are circumstances of the greatest importance in such machines.

The great simplicity of this improved machine consists, the author observes, first, in its having only a seed-box, and not both a hopper and seed-box as in some others, as that of Mr. Cook; secondly, in the flues which conduct the seed from the bottom of the seed box into the drill-furrows not being disjoined in the middle, in order to permit the lower part to move to the right or to the left, when the horse deviates from the line in which the coulters pass, as in Mr. Cook's machine, which in this is performed by a simple universal joint; thirdly, in the horns or shafts behind, between which the person goes who regulates the coulters, being equally fixed to the coulter-beam and the axle-tree; while in others, as that we have just mentioned, they are all of them moveable joints, like a parallel rule for the purpose of counteracting the swerving of the horse, which is here done by a simple universal joint; fourthly, in altering the dimensions of the holes in the axis of the seed-box, by simply turning a screw, so as so adapt them to all kinds of seeds which are usually sown on field-lands; fifthly, in the strong brush of bristles which sweep over the excavations of the cylinders beneath the seed box, strickling them with such exactness that no supernumerary seeds escape, and that none of them be the least broken or injured, which is the case in other machines, as the original one of Mr. Tull; and lastly, in its greater simplicity rendering it less expensive in its construction, and less liable to be out of repair, as well as the management of it more readily and more easily understood.

In the same ingenious and philosophical work the author also describes a seed-box, the invention of Mr. Stanwick, of Derby, by which the seed may be deposited with still greater accuracy. This box is forty-eight inches long within; which space is divided into six cells, for the purposse of sowing six rows of seed at the same time, as in that just described; and at the bottom of each is a hole for the seed to pass through into the seed-flues, but without any revolving axis, a wooden bar about four feet eight inches long, and three-eighths of an inch in thickness, through which there are six perforations, each of them exactly one inch long, half an inch wide,

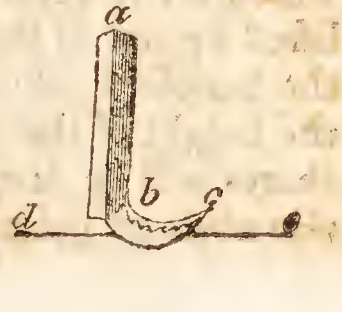
and three eighths of an inch deep, which is the thickness of the bar that supplies its place. The centres of these holes are exactly eight inches distant from each other, correspondent to the holes at the bottom of the seed-box, over which it is made to slide backwards and forwards in a groove. In this sliding motion it passes under stiff brushes, which are placed over it on each end of the holes, at the bottom of the seed-box, and strickle off the grain as the holes in the sliding bar pass under them, by which the quantity of seed is measured out with a considerable degree of accuracy. And in order to increase or diminish the quantity of grain delivered, the slider is covered with a case of tin, which has six perforations, exactly corresponding with the holes in the slider; but instead of the bit of tin being cut out the whole length of the hole, part of it is left at one end equal to the thickness of the slider, and is bent down after the slider is put into the case, in the same manner as the tin cylinder in the above machine. This case is moveable about an inch backwards and forwards by turning the finger-screw, and thus the holes are made larger or smaller in order to suit various sorts of grain, or different quantities of the same sort. The slider is moved forwards by a bent iron pin which is attached to it, and which passes into a serpentine groove fixed to the nave of the wheel, and backwards by a steel spring at the other end of the seed-box. It is observed that the simplicity of the slider at the bottom of the seed-box in this instrument may be, in some respects, greater than that of the wooden and tin cylinders in the former one, as this has but six holes to measure out the seed, while the other has twenty-four; but that, perhaps, in other respects it is less so, as in this there are twelve brushes, one on each side of each of the six holes, whereas in the former only six brushes rub upon the tin cylinder. It is probable too, that as the reciprocating motion of this slider must be quick, as it must act once every time the periphery of the wheel of the carriage has passed nine-inches forwards, it may not be so easy to execute as the cog-wheel and uninterrupted movement of the axis and cylinder in the preceding drill.

A machine of this kind, invented by Mr. Amos, and described in his treatise on drill husbandry, is said to be a good, cheap, and convenient tool. Grain, seeds, and pulse of all sorts, are asserted to be easily sown by this instrument on every description of land, in any quantity, and at such depths and distances as may be required. It is constructed with spherical cups, and sows, at a great variety of distances, both in respect to the rows and the intervals, performing its business with much dispatch and little strength of draught. The drill part of the machine may be fixed to the beam of any common plough. There are, however, several other implements of the same kind made by different persons, which have been found to perform equally well.

Mr. Cook's *improved drill* is in many respects, a well-constructed implement, and on certain light soils is found to answer perfectly; but on others it is said to be liable to deliver the grain with some inequality. An intelligent agriculturist, who has had much experience of it, however, remarks, that it is an implement which will

deposit any quantity of seed on the acre, at any required depth, with intervals of eight, nine, eleven, or eighteen inches; and at two, three, or four feet width, with considerable exactness: and that, wherever it fails of success, he supposes it must proceed from the want of proper attention in the person who makes use of it. With him it has been found useful upon all soils, exceept such as are stony or rocky, and he thinks it may be employed with equal advantage on strong clays and clayey loams as on those of the lighter kind. This drill is constructed somewhat on the same principle of that which has just been mentioned, and is certainly capable of pretty general application. It is likewise capable of being converted into a horse hoe. A representation of the drill machine is given at fig. 1. in plate XXII.; in which *a a* shows the shafts applied to the axis of the wheels; *b b* the wheels; *c c* the coulter-beam, having holes at proper distances for the coulters; *d d* the handles fixed to the coulter-beam, as well as the axis of the wheels, by staples or hooks and eyes; *e e* upper seed-box, in partitions, covered by a lid; *f f* lower seed-box, in partitions; *g g* slides between upper and lower seed-boxes, for regulating the quantity of seed; *h h* cylinder with cups of different dimensions for grain or seeds of different sizes, which take up and drop the seed into the funnels *i i*, to be conveyed to the drill in the land *k k*; *l* a hook to the axis of the wheels, to receive the links of a chain from the coulter-beam, in order to prevent the tubes from being displaced in crossing gutters, &c.; *m* a pin of iron projecting from the coulter-beam, which by being lifted on hook *l* bears the coulters out of the ground, in turning &c.; *n* a cog-wheel; *o* another cog-wheel turned by wheel *n*; *p* a laver and string passing over pulley to the axis of the cylinder *h*, by moving which to the notch in staple *q*, the wheel *o* is lifted out of generation with wheel *n*, by which means the distribution of seed is prevented at pleasure; *r* an iron bar perforated with holes, by which, with the pin put through the holes, the seed-box may be elevated or depressed so as to keep the lid level in all situations; *s s* two staples in the ends of seed-box, for receiving slips of wood with canvass, to prevent the wind interrupting the seed, as well as dirt from falling from the wheels into the funnels *i i*. A machine of this kind, invented and employed by Mr. Duckett, is also simple in its nature, and likewise said to be capable of being managed with great ease by an ordinary workman.

It has been remarked by an ingenious cultivator, that on some very stiff clayey soils the ordinary cuneiform coulters have been found incapable of penetrating to a sufficient depth without the assistance of extraordinary weight and pressure. This great inconvenience has been some measure overcome by adding to the extremities of the coulters a blade of iron to precede them, curved like an inverted scythe, or turned up, as it were, like the toe of a skate, thus: *a b* is the old-fashioned coulter (the groove which conducts the seed being left blank), and *b c* is the curved knife now added to facilitate its insertion; *d e* is intended to represent the level of the land. This



construction of the coulters seems to possess the double advantage of facilitating their insertion into the ground, and of affording some resistance to any occasional obliquity of direction to which the machine may be urged.

And a machine of this kind, which the Kentish farmers find very convenient for drilling wheat, barley, oats, peas es, and various other crops, is made by Mr. Wellard, of Deal. It is drawn by two horses a-breast in a double pair of shafts, and drills seven rows at a time, seven inches apart. From the peculiarity of its consttuction, any quantity of grain required per acre can be drilled, and from its great simplicity it is not liable to be put out of order. It costs about fourteen guineas.

A simple *drill* of the single kind is shown in plate XVIII at fig 1. in which *z* N is the screw to 2 K, the regulator; *c c* the cord to lift the wheel up when not wanted to turn the seed out. Fig. 2. the seed wheel, and seed-casting cylinder, *n h* the notches; *e e* the seed. Fig. 3. front view of hopper, showing part of the seed-casting notches; *o x* the mouth where the seed passes; *o* K part of the regulating tongue. Fig 4. is a section of the seed-casting notches.

The dimensions in fig. 1, are:

	Ft.	*In.*		*Ft.*	*In.*		*Ft.*	*In.*
a b,	6	6	b i,	1	9	e e w,	1	6
a K,	1	3	i E,	2	7	o x,	0	2
b 39,	3	3	o t,	1	0	In fig. 3.		
h 34,	2	10	i o,	1	3	12 d,	1	0
h n,	2	0	e o,	1	6	d 9,	1	6
h 4,	3	4	o 8,	6	6	9 18,	1	0
a X,	1	4	e 8,	8	0	12 18,	1	6
x 9,	1	2	Diameter.			3 5,	0	3
9 18,	1	0	W,	2	0	5 H,	0	5
18 12,	1	6	In fig. 2.			4 2,	0	4
Xn,	0	10	x 10,	0	10	2 x,	0	2
N z,	0	7	x 19,	1	7	x 4,	0	2
z x,	0	11	W 24,	2	0	K 2,	0	1
a 5,	3	5	19 6,	2	1	o x,	0	1
x 5,	2	1	6 X	0	6	In fig. 4.		
5 p,	1	8	6 i,	0	$1\frac{1}{2}$	x i,	0	2
p 20,	1	8	i x,	0	$4\frac{1}{2}$	i o,	0	$0\frac{6}{10}$
b 6,	0	6	x h,	0	$1\frac{1}{2}$	i 4,	0	$0\frac{1}{2}$
			n h,	0	$1\frac{1}{2}$	10,	0	$0\frac{6}{10}$

This *drill* is in use in Oxfordshire, and found to answer for certain kind of crops.

Another drill which performs several rows at the same time, has been constructed by Mr. Emerson, of the same county; and is shown in plate XIX. in which fig. 1. is the fore or turn wheels, which are to return the machine, as represented by the handle T, lifted up out of the little iron fork *f*; but to work straight forward, the handle T, should rest in the fork *f*, and the notches regulate the height of the fore-wheels; according to which regulation the shares will be deeper or otherwise into the ground; the shares are also made to point downwards. Fig. 2. shows exactly the end view

A Single Drill.

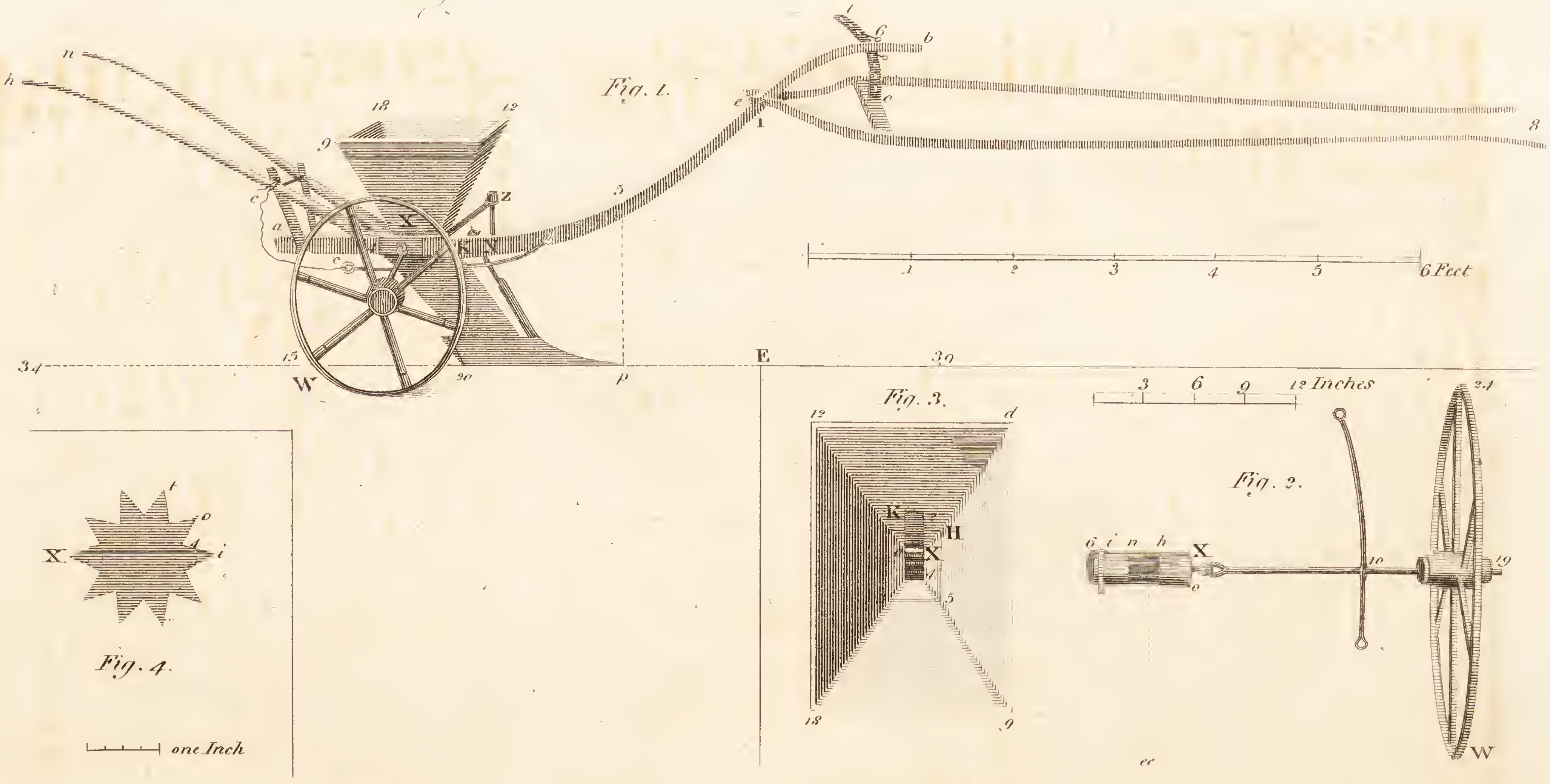
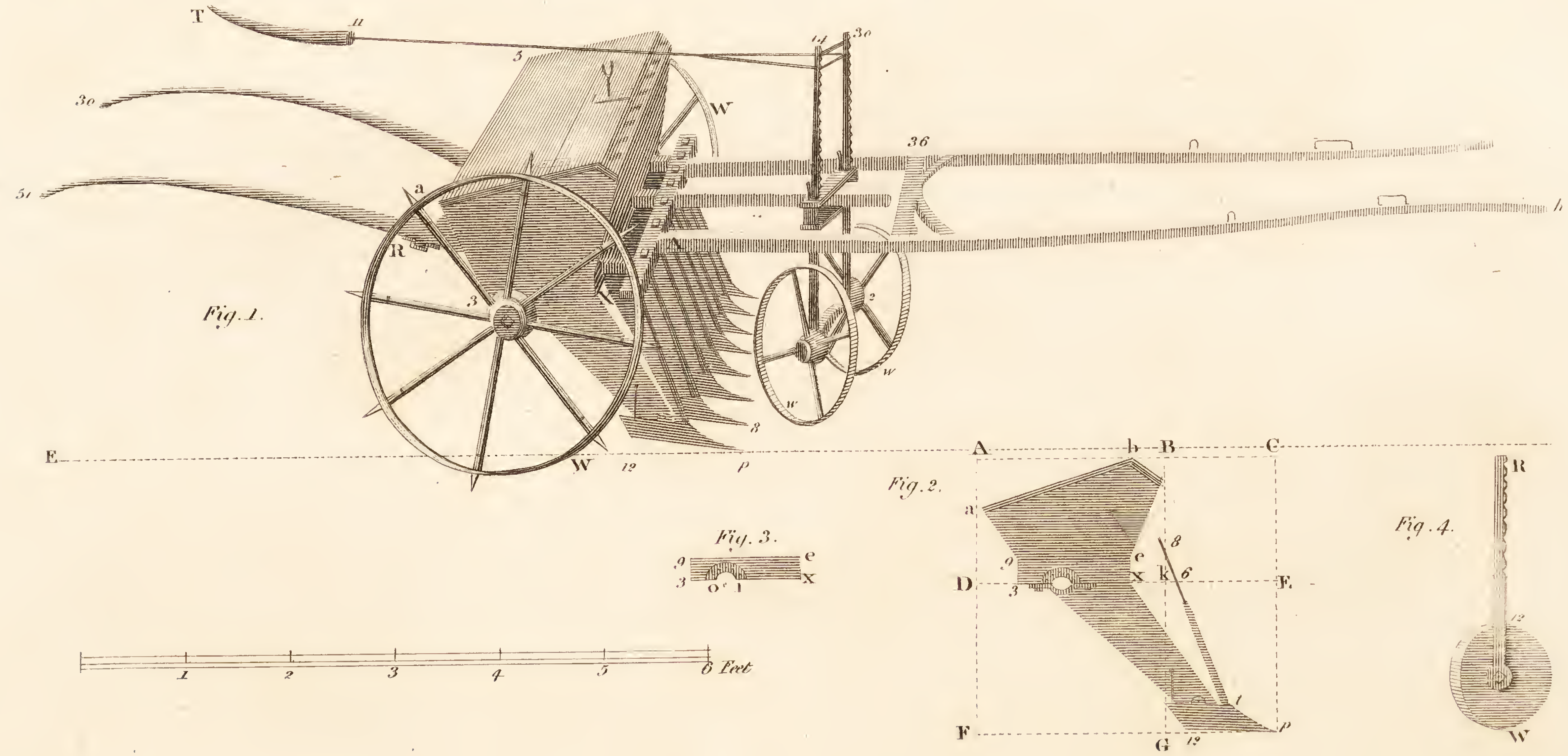


Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Mr. Emerson's Drill.



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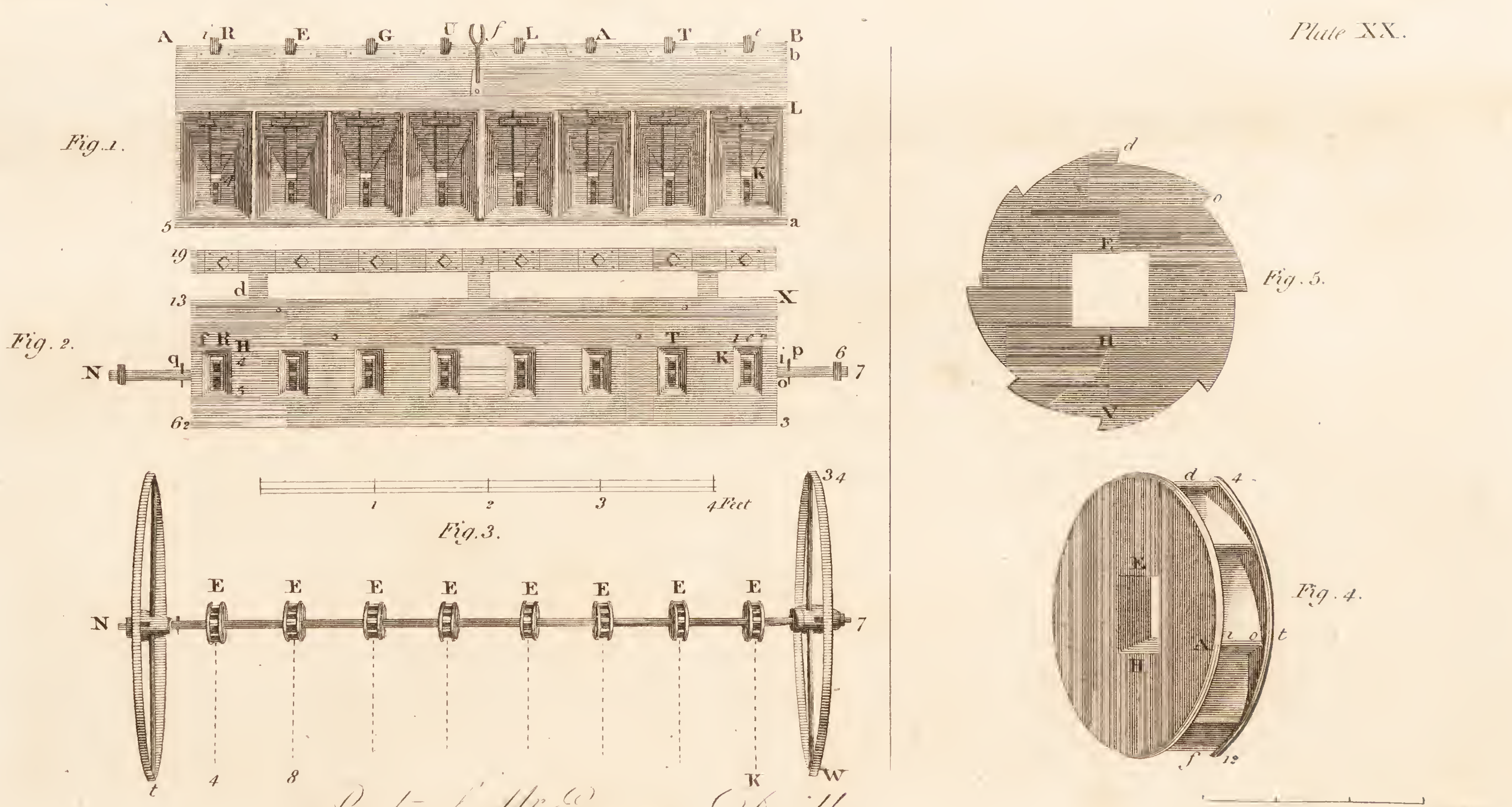


Parts of Mr Emerson's Drill.

of the box and share. Fig. 3. the end view of the large beam, showing where to fix the spindle. Fig 4. a little wheel, used only when wanted to remove the drill to another field: to keep the shares and seed-wheels from the ground, one is to be fixed at each handle as at R, and at the same time the fore-wheels should be let down, and the shares and the seed-wheels not touch the ground. Fig. 1. represents it as it is used in the field, where it performs well.

Fig. 1.	*Ft.*	*In.*	Diameter.	*Ft.*	*In.*		*Ft.*	*In.*
51 30,	2	6	W,	2	10	k E,	1	2
E 51,	2	6	w,	1	6	E p,	1	5
51 R,	3	6				G k,	1	5
51 3,	4	3	Fig. 2.			G p,	1	2
A h,	8	6	A C,	2	11¼	p 12,	1	0½
A H,	2	6	F p,	2	11¼	x p,	2	0
H 36,	3	0	A F,	2	9	p t,	0	7
2 30,	2	6	C p,	2	9	t 6,	1	3
30 14,	1	2	A B,	1	9¼	t 8,	1	8
14 n,	4	4	A D,	1	5¼	x 6,	0	6
n T,	1	4	D 3,	0		a 1,	1	0
14 T,	5	8	3 x,	1	1	Fig. 3.		
A 3,	1	7	x e,	0	3	e x,	0	3
x 3,	1	1	e 9,	1	1	x 3,	1	1
3 a,	1	0	9 3,	0	3	3 o,	0	5
a 5,	5	5	9 a,	0	9	i x,	0	7
x p,	2	0	a b,	1	7	o i,	0	1
p 12,	1	0½	b F,	0	2¾	Fig. 4.		
p 8,	0	8	f e,	0	11	W R,	2	6
			x k,	0	3	W 12,	1	0

Plate XX. shows the different parts of the same drill. Fig. 1. a front view of the seed boxes, showing the eight regulators. Fig. 2. the large beam, where the seed casting wheels work under the boxes. Fig. 3. N 7, the spindle; t W, the large seed wheels; E E, the seed casting wheels; K 4, the seed. Fig. 4. the seed casting wheel, the same as E, on a larger scale. Fig. 5. a section of the same seed casting wheel without its sides, exactly explaining its notches and their inclination, each notch casting seed upon every twelve inches and three quarters of ground, its revolution being eleven inches and five eighths, and the revolution of each of the large seed wheels that mark the ground eight feet six inches. It sows five feet four inches at once.

Fig. 1.	*Ft.*	*In.*		*Ft.*	*In.*		*Ft.*	*In.*
A B,	5	5	i e,	4	9¼	A T	0	8
B b,	0	2¾	i R,	0	1¼	T e,	0	8
a b,	1	7	R 4,	1	7	e K,	1	7
a L,	1	0	R E,	0	8	R e,	4	3
a 5,	5	5	E G,	0	8	Fig. 2.		
A f,	2	8½	G U,	0	8	19 62,	1	7
f B,	2	8½	U L,	0	8	62 13,	1	1
A i,	0	3⅞	L A,	0	8	62 3,	5	2

	Ft.	*In.*
3 x,	1	1
o 3,	0	5
i 3,	0	4
3 x,	1	1
i p,	0	1
i 6,	0	6
i 7,	0	7
P q;	5	4
N q,	0	6
N 7,	6	6
f H,	0	$2\frac{3}{4}$
H d,	0	5
H 5	0	5

	Ft.	*In.*
5 4,	0	4
1 2,	0	$2\frac{3}{4}$
1 K,	0	1
e T,	0	8
R c,	4	8
Fig. 3.		
N 7,	6	6
W 34,	2	10
W t,	5	11
t 4.	0	$7\frac{1}{2}$
K W,	0	$7\frac{1}{2}$
K 4,	4	8
4 8,	0	8

Fig. 4.

Diameter.

	Ft.	*In.*
E,	0	4
12 4,	0	4
s d,	0	$3\frac{7}{8}$
E H,	0	1
A t,	0	1
i o,	0	$0\frac{5}{8}$
Fig. 5.		
s d,	0	$3\frac{7}{8}$
v s,	0	$0\frac{1}{5}$
o d,	0	$1\frac{18}{10}$

Turnip-drills.—An useful instrument of this sort has been contrive by Mr. Bailey, for sowing turnips on the tops of one-bout ridges In this implement the defects of sowing too much or too little see are obviated. It consists of a solid cylinder, made of iron or brass about two inches in diameter and one inch broad, on the surface o which are formed fifteen or sixteen cavities resembling the form o a semi-egg when cut longitudinally, and as deep as to hold four o five seeds each. On the back of the cylinder, a little from the top is placed the hind part of the hopper, to which is fixed a piece o iron or brass one inch long and half an inch broad, hollowed on th inside into the form of a Gothic arch, the sides of which meetin the sides of the cavities in an oblique angle, prevent the seeds fron being bruised: at the lower end of this piece of iron, or gatherer there is a slit three tenths of an inch long and one-tenth wide: an at the back of it, a thin flat piece of iron moves up and down b means of a screw at the top of the hopper, which enlarges or less ens the orifice directly above the cavities, and increases or dimi nishes the quantity of seed delivered, as the operator may thin proper. This slip of iron, or regulator, is let into a groove mad in the board which forms the back part of the hopper.

The cylinder is fixed, before the cavities are made, on an iro axle one inch square, turned very true, as well as those parts of th axle which turn in the collars fixed in the handles. To the ends o the axle, two wheels, twenty-six inches in diameter, are fixed which turn the axle and cylinder round, and which, in passin through the hopper containing the seed, bring forward in eac cavity a number of seeds and drop them into the spout, by whic means they are conveyed to the coulter, which forms a channel o the top of the one-bout ridge in order to receive them.

If the cavities in this drill be made hold five seeds when the re gulator is screwed close down, and there be sixteen of them, it wi deposit eighty seeds each revolution; and from the diameter of th wheel being twenty-six inches, and the circumference eighty-on inches and a half, eighty seeds will be sown in eighty-one inche and a half, or nearly twelve in a foot. This being the *minimum* quantity, by screwing up the regulator the number may be increase

DRILL MACHINES

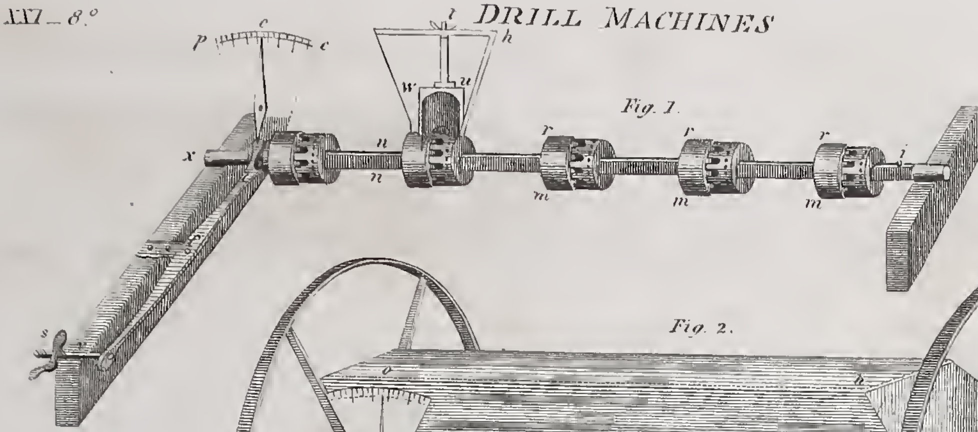


Fig. 1.

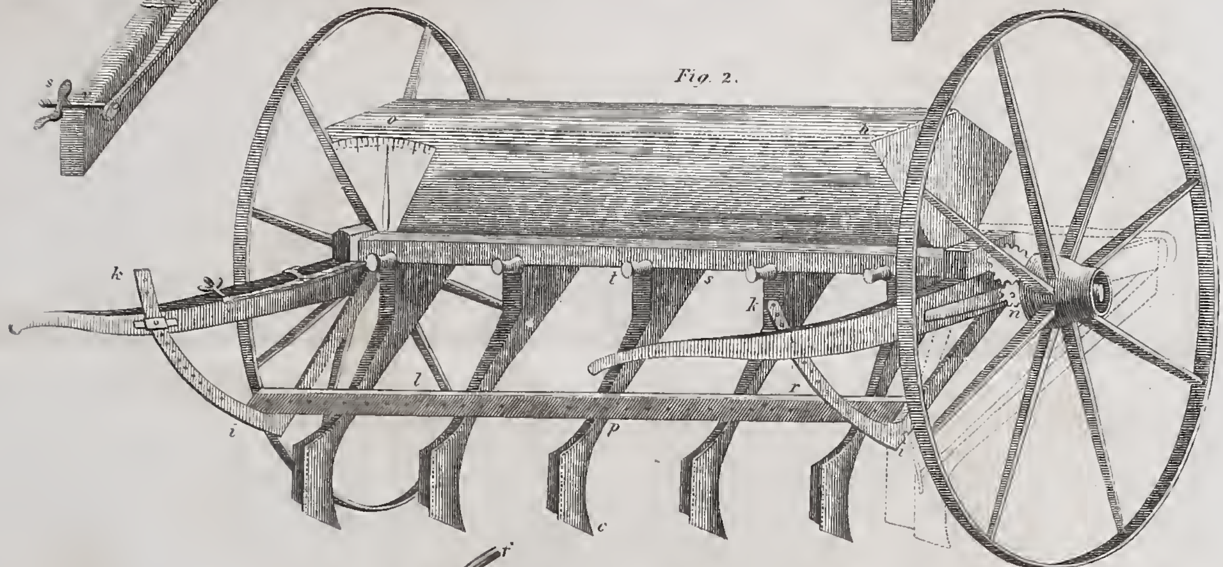


Fig. 2.

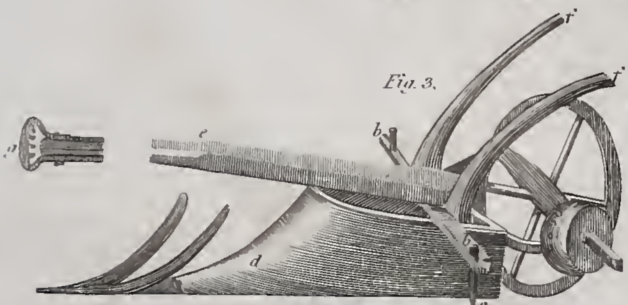


Fig. 3.

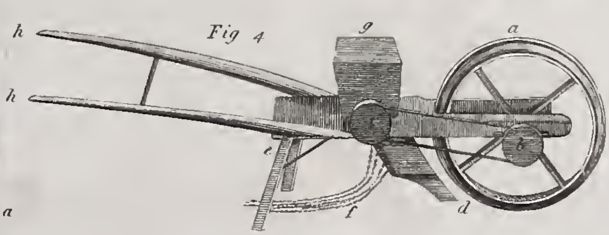


Fig 4

gradually to fifty or sixty in a foot; which is far more than is necessary, except in particularly unfavourable situations. A representation of it is given in the Northumberland Agricultural Report.

Another *drill* constructed by the same gentleman for sowing all kinds of grain, in any quantity, and at any distance, seems likewise to have considerable merit. The inside part of it, by which the quantity of seed is regulated, is an iron axle one or one and one-fourth of an inch square, upon which are fixed, at nine or ten inches distance, five or six or more brass fluted cylinders, the flutes being rather more than a semi-circle five-eighths of an inch in diameter, or five-eighths wide and six-eighths in depth. To these are fitted hollow cylindrical rims of hammered iron, which have segments turned down at right angles, to form exactly to the flutes of the brass cylinders, the cavities of which are increased or diminished by the segments of the iron cylindrical rims sliding backwards and forwards in the flutes. This is performed in all the cylinders at the same time, by a rectangular space being made in the brass cylinders, through which passes a straight piece of iron moving on friction wheels, and fastened to the plates, and also the cylindrical rims. A lever moved by a screw passes through the frame; one end of which is forked, and made to fit exactly the sides of the collar or plates of iron. By turning the screw the lever moves the whole of the rims at once, and the cavities are increased or diminished at pleasure, and almost instantaneously, even while the machine is going and at work, so as to sow all sorts of grain, and in any proportion.

When *turnips* are to be drilled, the large hopper is taken off, and a set of small ones fixed upon the half-egg cavities at the end of the brass cylinders, and the quantity of seed regulated as in the turnip-drill just described.

Fig. 1. in plate XXI. represents the inside part of this useful machine, by which the quantity of seed is regulated. *a x* an iron axle, one or one inch and a quarter square, upon which are fixed, at nine or ten inches distance, five, six, or more, brass fluted cylinders, the flutes being rather more than a semi-circle five-eighths of an inch diameter, or five-eighths wide and six-eighths deep. *r m* are hollow cylindrical rims of hammered iron, which have segments turned down at right angles, to fit exactly the flutes of the brass cylinders; the cavities of which are increased or diminished by the segments of the iron cylindrical rims sliding backwards or forwards in the flutes. This is performed in all the cylinders at the same time, by a rectangular (space) being made in the brass cylinders, through which passes a straight piece of iron *i n*, moving on friction-wheels at *i*, and fastened to the plates at *l k*, and also to the cylindrical rims *r m l v* is a lever, the fulcrum of which is *f*, and moved by a screw S, passing through the frame at V. The end at *l k* is forked, and made to fit exactly the slides of the collar or plates of iron *i k*. By turning the screw S, the lever moves the whole of the rims at once, and the cavities are increased or diminished at pleasure: this is done with the greatest facility and readi-

ness, even while the machine is going and at work; which is frequently necessary, where the land varies considerably in quality upon different parts of the same ridge; and almost instantaneously, to sow any kind of grain and in any proportion; which is shown upon the scale *e o p*, by the index *k o* fixed to the end of the lever at *k*. And fig. 2. is a view of the machine when ready for work. The coulters and spouts may be hung differently, as represented by the dotted lines, and which is probably the better mode for hilly lands.

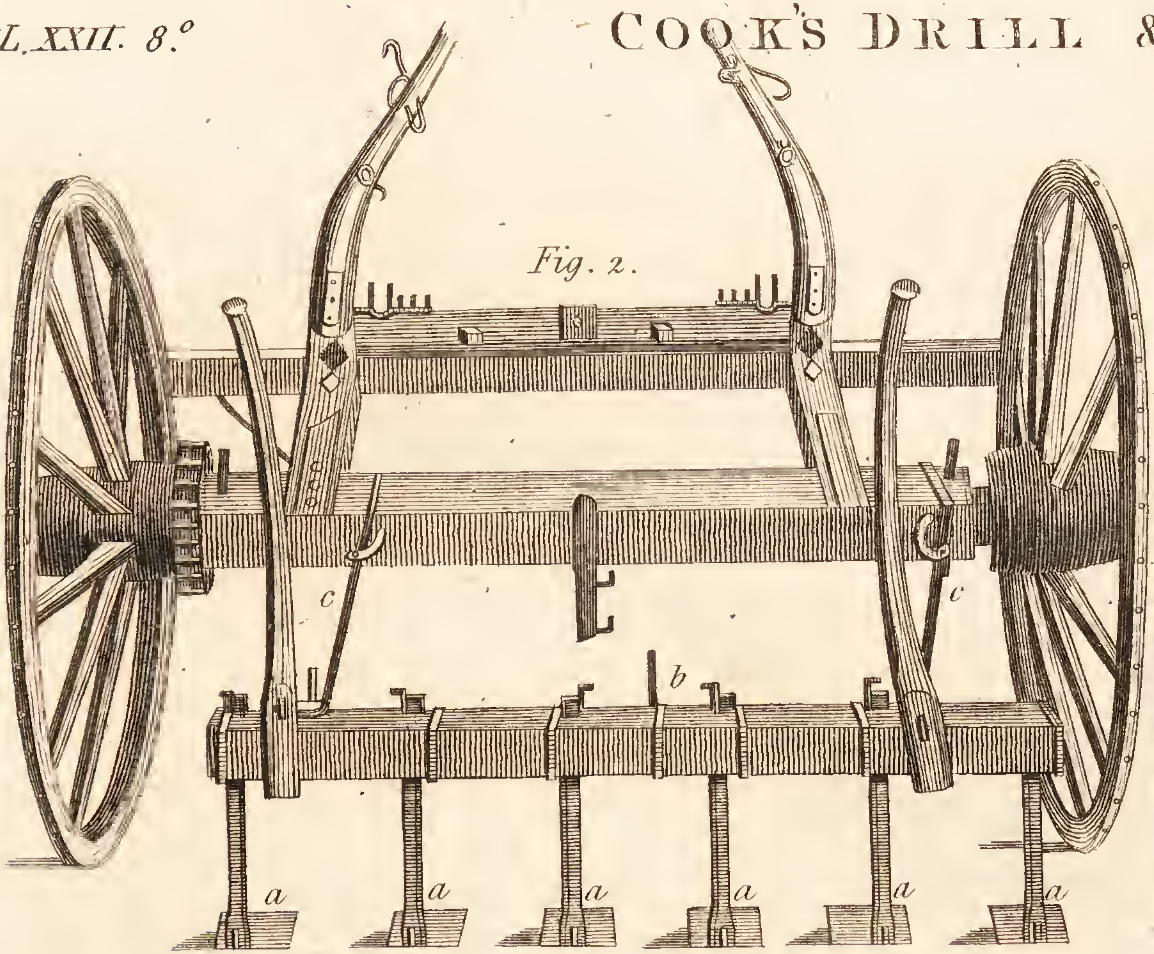
For sowing beans and peas at wide intervals, as from twenty-seven to thirty inches, Mr. Bailey makes use of a drill with only one wheel and one cylinder, which a man wheels before him in the furrow: or a method which he finds better is, to fix it in the body of a small plough drawn by one horse, with one stilt that passes between the wheel and seed box. By this means the wheel moves on a smooth surface between the land side and mould board, and the seed is deposited at a regular depth. For beans he finds two inches to answer very well. By means of the same plough he has sown both wheat and barley at different intervals from six to twelve inches, and one and a half or two inches deep, with good success; and for small concerns, he thinks that this cheap and simple apparatus will be found very eligible and advantageous. The drill is fixed to the plough by two pieces of iron going from the ends of it, one to the beam and the other to the stilt; which, moving round on bolts, allow the wheel to fall and rise with every accidental hollow or eminence. The lower part of the coulter is kneed, or bent, to bring it to the same plane with the land side of the plough.

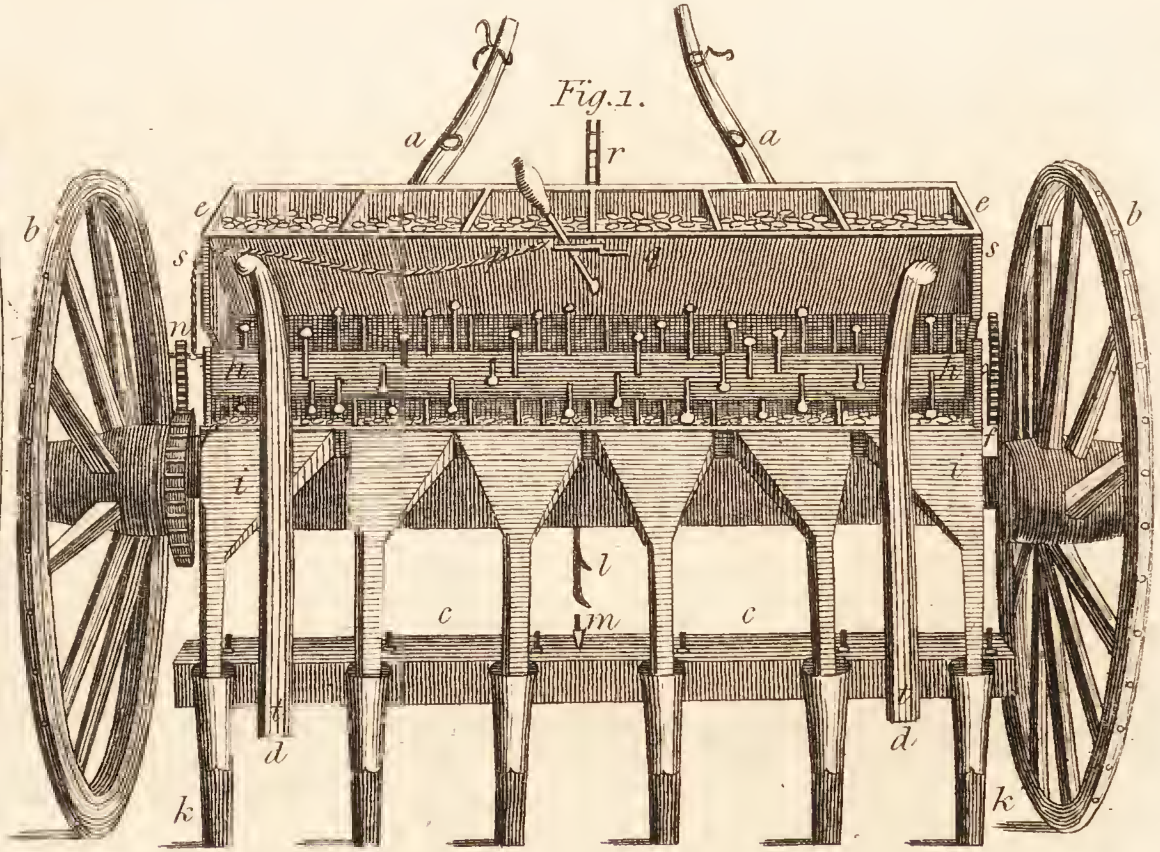
At fig. 3. in the same plate, is seen a drill plough useful in sowing turnips, invented by Mr. Mure; in which *a* is the spindle on which the seed box is fixed; *b b* the cross piece in which the drill coulter *c* is fastened; *d* the mould board; *e* the beam; *f f* the handles; *g* the copse by which it is drawn.

The *drill barrow* is an instrument contrived with much simplicity, and well adapted for sowing some grains and small seeds, as it can be readily regulated in respect to the proportion of the seed. It, however, sows only one row at a time, which in many instances is inconvenient. This machine would be much improved if it were made to drill several rows at once, and capable of being regulated in respect to distances for the seed. In some places this drill is much esteemed for putting in bean crops, in doing which it delivers into the furrow. At fig. 4. in the above plate, is the representation of a turnip-drill of this sort, invented by Mr. Knight. *a* the iron wheel running on the edge formed by two concave sides, makes the groove for the seed; *b* a wheel moving on the same axis with the former, and turning the wheel *c* by a strap, gives out the seed. By having different sizes of wheels, *d b*, more or less is sown as they increase or diminish the rapidity of *cd*, the tube through which the seed passes into the channel formed by the iron wheel; *e* feet of the implement; *f* six lengths of jack chain for covering the seed; *g*, the seed box; *hh* the handles. There are two holes before the axis of the great

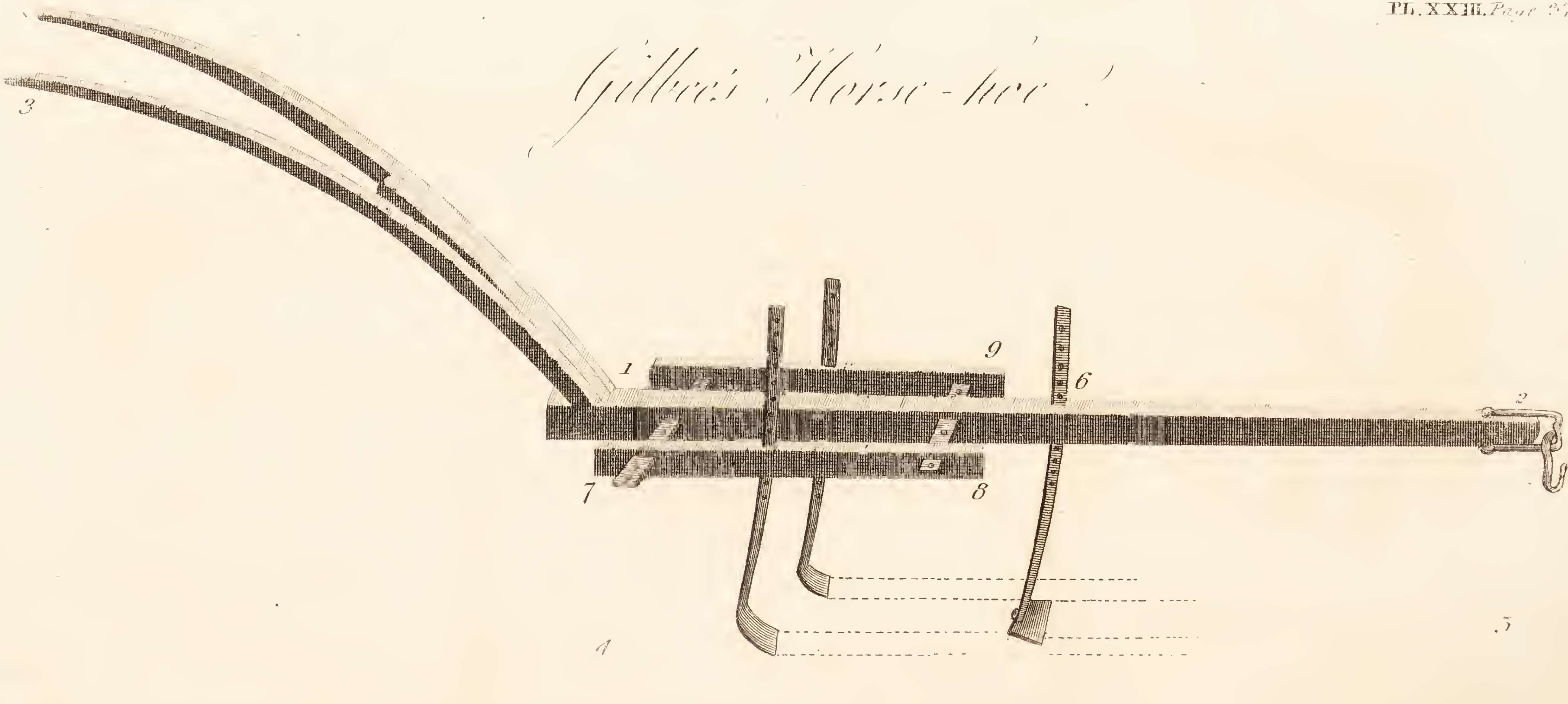
PL. XXII. 8.°

COOK'S DRILL & HORSE HOES.



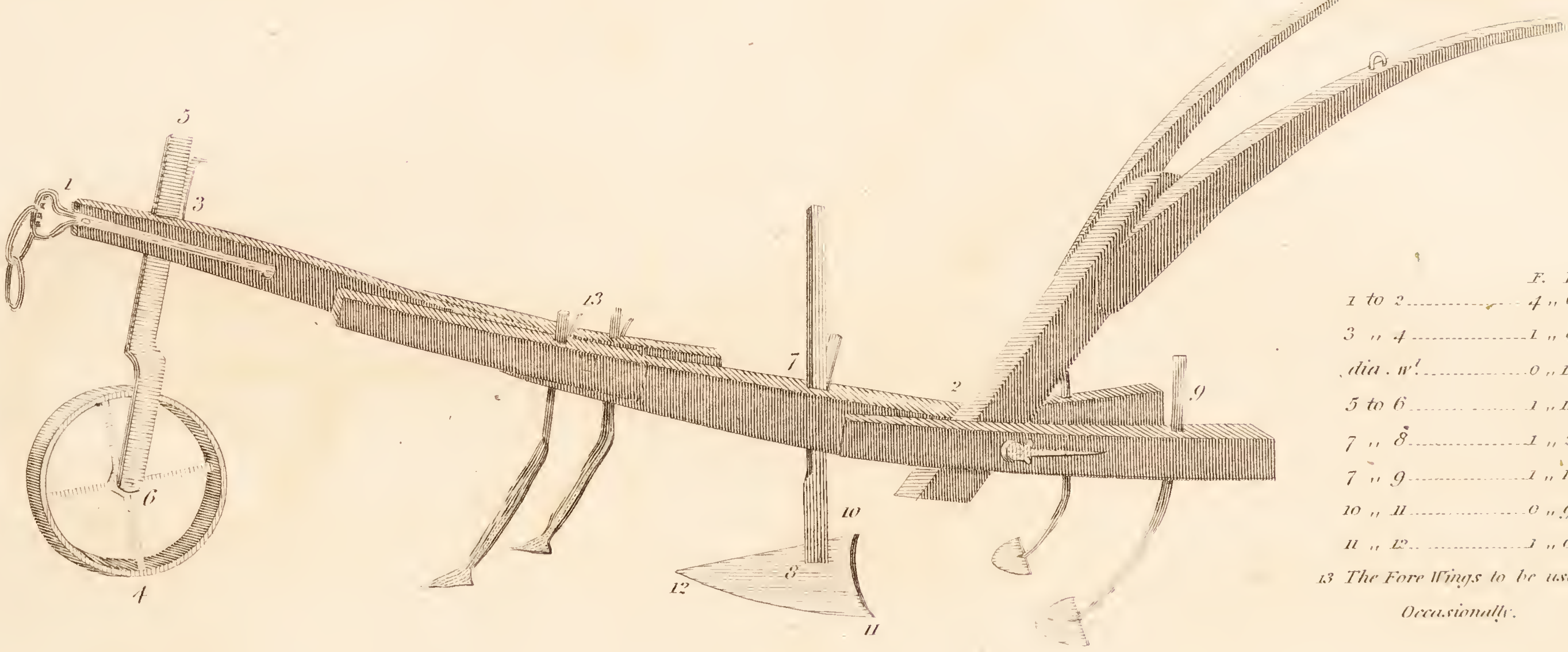


Gilbert's Horse-hoe.



Neele sc. Strand.

Mr. Tweed's improved Horse Hoe.

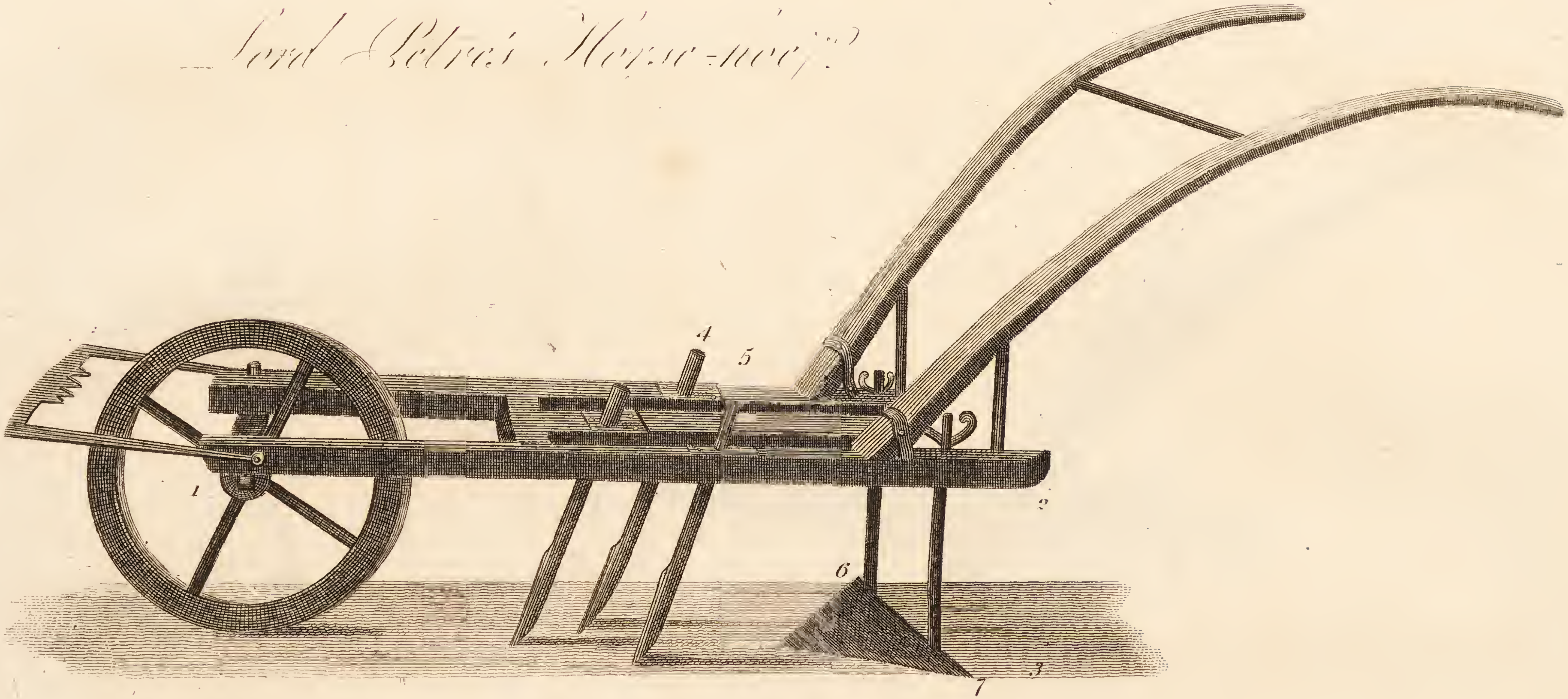


		F.	In.
1 to 2	....	4	6
3 " 4	....	1	8
dia. wl.	....	0	11
5 to 6	....	1	11
7 " 8	....	1	2
7 " 9	....	1	10
10 " 11	....	0	9
11 " 12	....	1	0

13 The Fore Wings to be used Occasionally.

Neele sc. Strand

Lord Petre's Horse-hoe.



Neele, sc. Strand.

wheel for receiving two pieces of cane, which mark the proper width of the intervals between the rows. The angle on the edge of the wheel and the weight of the implement are more or less acute and heavy according to the strength of the soil.

HOES.—Of this kind of tools there have been a great number invented at different times, both for the purpose of being drawn by horses, and used with the hand. Mr. Cook's improved horse hoe is unquestionably a good implement for hoeing crops at certain distances; but for narrow irregular distances the expanding horse-hoe, contrived by Mr. Amos, is probably a preferable instrument, as its moveable shares render it capable of being regulated to different spaces, according as the crops may have been drilled with greater or less intervals. It will be found most useful on light friable soils, and where the ground is in a mellow condition. This hoe is constantly made use of by some good farmers in Lincolnshire for beans, cabbages, potatoes, and such like crops, and found to be very effective.

At fig. 2. in plate XXII. is a representation of Mr. Cook's drill, when set for horse hoeing. The shafts, axis, wheels, coulter beam and handles, the same as in fig. 1.; the seed box *e e*, the cylinder *h h*, the funnels *i i*, and the coulters *k k*, being removed; and the hoes *a a a a a a* introduced in the place of the coulters; *b c* a guide rising from the hoe beam for directing the hoes; *c c* the shanks by which the machine is drawn

A tool of this sort used with success by Mr. Gilbee, in Essex, is seen in plate XXIII. The dimensions of which are:

			Ft.	In.				Ft	In.				Ft.	In.
From	1 to	2	4	7	From	4 to	2	0	9	From	5 to	6	0	5
	3	4	4	7		1	5	0	10		6	7	0	4
	3	1	0	9										

A still more powerful implement of the same kind is shown in plate XXIV. It was in use by the late Lord Petre. The dimensions are:

			Ft.	In.				Ft.	In		Ft.	In.
From	1 to	2	4	0	From	4 to	5	1	0	Diam. of Wheels	1	8
	2	3	1	0		6	7	1	1			

And an improved *horse hoe*, employed by Mr. Tweed, in the same county, is represented in plate XXV. the dimensions of which are seen with the figures.

An useful implement of the *horse hoe* kind, for working in wide intervals, will be described in speaking of the nature of hoeing.

M'Dougall's *improved hoe* is constructed on a simple principle, and answers the various purposes of a hand-hoe with great ease and convenience, especially where the grain or pulse has been sown in equidistant intervals. The wheel in this instrument should, however, be made solid, as the open wheel is liable to clog and fill up when the ground is soft and wet. A representation of it will be given in speaking of hoeing.

In mellow soils, and where hand-hoeing is practised, the implements of this kind which have been invented by Mr. Ducket are probably more useful; as from their being heavier in the iron work, and having shorter handles than those in common use, they would seem to be more effective. They are represented under the above head. Hoes in some respects similar to these have long been in use for hoeing the strong land of the vineyards in Portugal.

But notwithstanding these instruments, the business of hoeing may frequently be well performed on stiff soils, and where the distances of the crops are pretty wide, with any common small plough that has a broad sharp share. With those instruments the workman can go to what depth and as near the rows as he pleases. It has been observed, and probably with truth, by a late writer, that he can find nothing equal to a "plough for the purpose of cleaning land and earthing the crops. He has tried," he says, "double-moulded or double-breasted ploughs to earth up the rows, but that they will not at all do in drill husbandry, as you cannot humour them to the widths of the rows, which are sometimes a little wider or narrower; and if they vary but an inch or two, it destroys the effect intended, as the mould cannot be regularly raised, and the corn will be in some places high, in some low. A common plough will perform this work to perfection; the expense amounts to not more than one shilling per acre, and the service rendered the crop is worth a pound at least, exclusive of the advantage of cleaning the land better than by any other means; for when you see a weed you may," he says, "with a common plough go sufficiently deep, or give it what direction you please."

And in speaking of this kind of tools he further remarks, that as such weeds as strike with a tap-root are not easily cut by the scarifier when it happens to be blunt, but are often dragged down and left growing, he has invented an instrument superior to the plough or scarifier for the purpose. "It is made," he says, "of a triangular form, with a beam, and two small wheels under the beam to run before it, in the same manner as in the Norfolk plough. There are three coulters, with a share riveted under each of them, made sharp at the point like a fleam, and about fourteen inches wide. The coulters penetrate under the mould as deep as the plough, and, without moving the earth much, cut up thistle, brackens, &c. better than any instrument he has yet met with. Where such weeds are very numerous, he uses a beam with one wheel, into which he puts one of the coulters, to cut between the rows of the drills: it will penetrate any depth required. The one with three shares will, with a pair of horses, do as much work in one day as three ploughs." It is however observed, that this machine will work only upon light land, where the fallow is well broken and nearly clean of twitch. Where kit-locks grow it will also, he thinks, be found very useful; and it is of such a simple construction that any person may make it. In considering the business of hoeing, other implements will be noted which may be useful in particular cases.

SCUFFLERS, CULTIVATORS, and SCARIFIERS.—These are instruments which are in a great measures similar to that just described, and which seem daily to be coming into more general use for the purpose of cleaning and rendering arable land suitable for the reception of the seed, as well as for scarifying and stirring the earth between the rows of drilled crops. They are likewise sometimes made use of for clearing stubble after the crop has been taken off, but for which they are not probably good tools. They are made of various forms and constructions, and have commonly a great number of iron plates, or feet, the edges of which are well steeled and kept sharp. These are mostly fixed to the ends of an equal number of iron bars forming a kind of legs. Some of these tools are also made with wheels, and others without them; the latter sort answer equally well for many uses, and are much less expensive. A pair of handles are generally fixed on behind, by which the implements are worked, and, by the difference in the degrees of pressure, are regulated in respect to depth at the pleasure of the person who has the management of them. The feet should have a sort of triangular shape, each of the sides of which may be about six inches in length. They should be so contrived as to cut up the roots of weeds at a good depth, and not be easily thrown out of the ground by such obstructions as they may occasionally meet with. They may be used with different numbers of tines or teeth, according to the difference of intention with which they are employed, and in proportion as the land is clean or foul, loose or tenacious. The implements of this kind which are made by Mr. Cook are very good ones: and others, contrived with great simplicity, are described in many of the Reports published by the Board of Agriculture.

Mr. Amos, in his useful work on agriculture and planting, has given a figure and description of an effective kind of *scuffle*, which has been found excellent in cleaning beans and peas stubble previously to their being sown with wheat. It is also very useful in destroying weeds upon fallows, where ploughing might be injurious, either from the land being too moist or very light. No instrument is, he says, better adapted for cleaning the land that has been sown with garden peas, previous to its being ploughed, harrowed, rolled, and drilled with turnip or rape seed in the latter end of July or beginning of August. One man with two horses will scuffle about six or eight acres per day. After the land has been scuffled, it should be harrowed twice or thrice, and the weeds collected in heaps, and burnt or otherwise destroyed.

The main object of these instruments is, that of lessening the use of the plough: and in certain situations and soils they may, without doubt, be employed with more advantage to pulverize the earth and clear the lands from weeds. Lands which have been once ploughed over, in preparation for barley or turnips, may be easily rendered clean and fine by them, and the usual subsequent harrowings and ploughings be made unnecessary. As the implement of this kind which has been described above cannot, as the inventor, assures us, be employed except where the ground is light, and "where the fallow is well broken, and nearly clean of twitch," it may be objected

to on that account. But there is, besides this, another objection to this sort of tools, which is that of their being liable to clog much when the land is wet, an inconvenience which considerably lessens their general application. In the construction of the improved *scuffler* employed in some of the midland districts, this inconvenience has however been attended to, and in a great measure corrected. The wheels in this instrument are made a foot and a half in diameter, and the length of the hoes two feet, having a slight curve. It is also so contrived, that it may be drawn by two horses a breast, or at length, as may be found most proper and convenient.

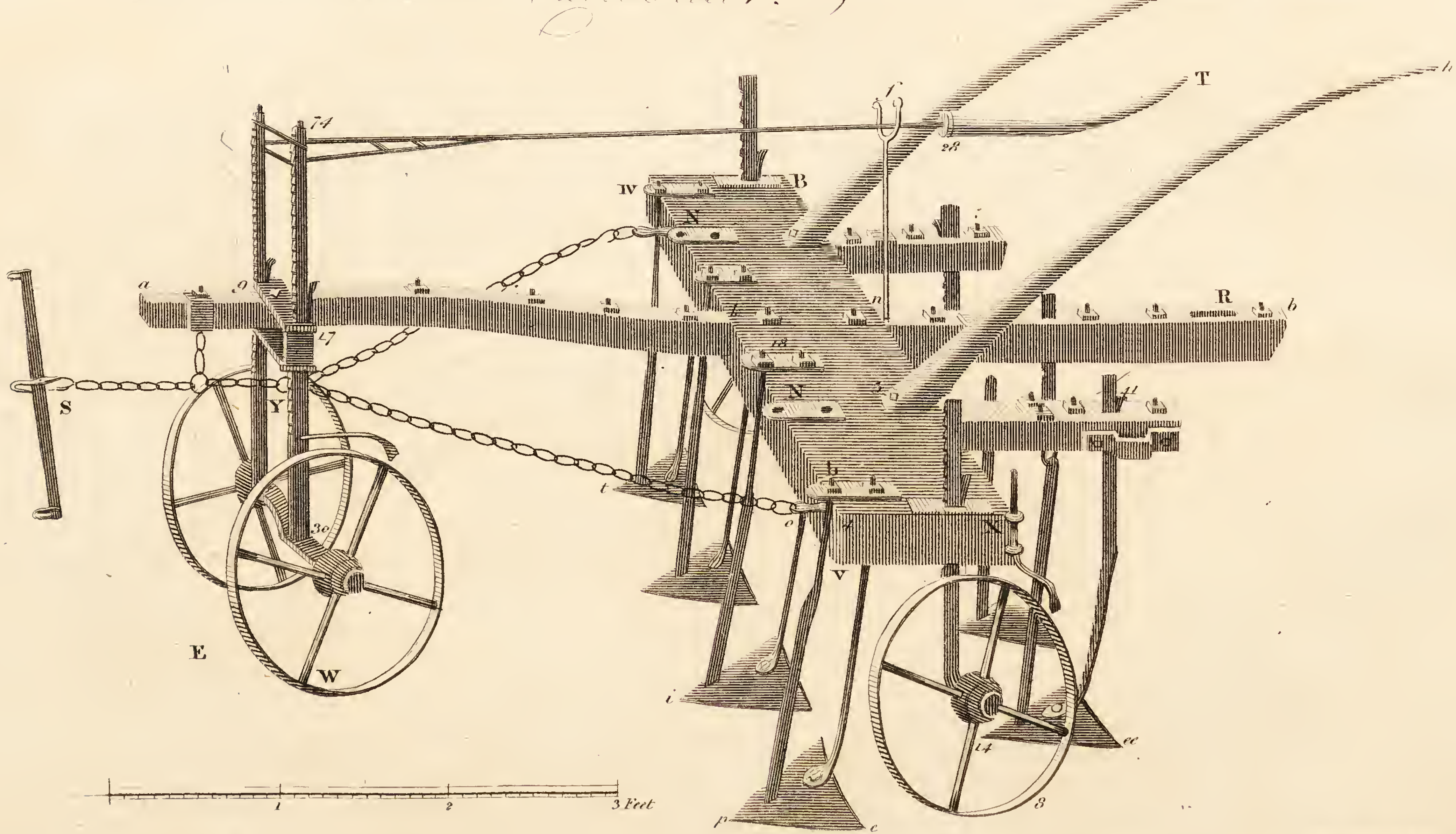
There is a *scuffler* employed with great advantage by Mr. Grayburn, in Lincolnshire, in putting in grain crops on turnip-fed lands after one ploughing. The seed is by this implement scuffled in, and the necessity of a second earth avoided. It is represented in the survey of that district. And an implement of the same kind, made use of in Northumberland, for hoeing bean-crops drilled at thirty inches, is likewise a good tool, capable of hoeing and stirring strong lands in dry seasons, when the plough cannot be employed. With other proper hoes put into it, the purpose of scufflers and cultivators, &c., is answered in a very cheap and easy manner. It is seen at fig. 2, in plate XXX. *a b* the beam five feet in length, and in height at *b* 16 inches; *c e* and *d e* curved lines having a radius of 24 inches from *c* and *d* as centres; *a* to *f* the length of stilts 42 inches; the length of the shanks of hoes from *g* to under side of beam 15 inches; length *g* to *b* 7 inches and a half; breadth from *g* to *i* 5 inches and a half; *c e*, *d e* holes in the side, and *c d* in the end, for the reception of smaller hoes for light soils, as to hoe from 18 to 30 inches at once. When made a little wider so as to take in four hoes, it answers well for hoeing wheat drilled at 10 or 12 inches. It is drawn by a single horse, and costs only from 30 to 40*s*. Fig. 3. shows the sizes of the hoes.

The *cultivator* is another tool calculated for the same purposes, the invention of Mr. Cook, to whose ingenuity the cultivators of land are greatly indebted. It consists of a diagonal beam, in which are placed a number of narrow shares; and when employed in this way is in many places termed a tillage scarifier, but when used with broad triangular shares it has the title of scuffler. The whole, when complete, forms the cultivator.

There are many other kinds of cultivators in use in different districts; Mr. Emerson's is an excellent tool of this sort, and is shown in plate XXVI. the dimensions of which are:

	Ft.	*In.*		*Ft.*	*In.*		*Ft.*	*In.*
a b,	7	1	h 25,	2	1	Y S,	1	6
x B,	5	2	T 28,	2	4	W 17,	2	3
x 4,	1	1	T 74,	6	2	E a,	2	3
v 4,	0	4	n f,	1	4	e 4,	1	11
n b,	2	6	74 30,	2	6	ee 41,	2	1
n R,	2	4	a 9,	0	9	a k,	3	6
5 h,	3	7	o Y,	3	2	N N,	2	0

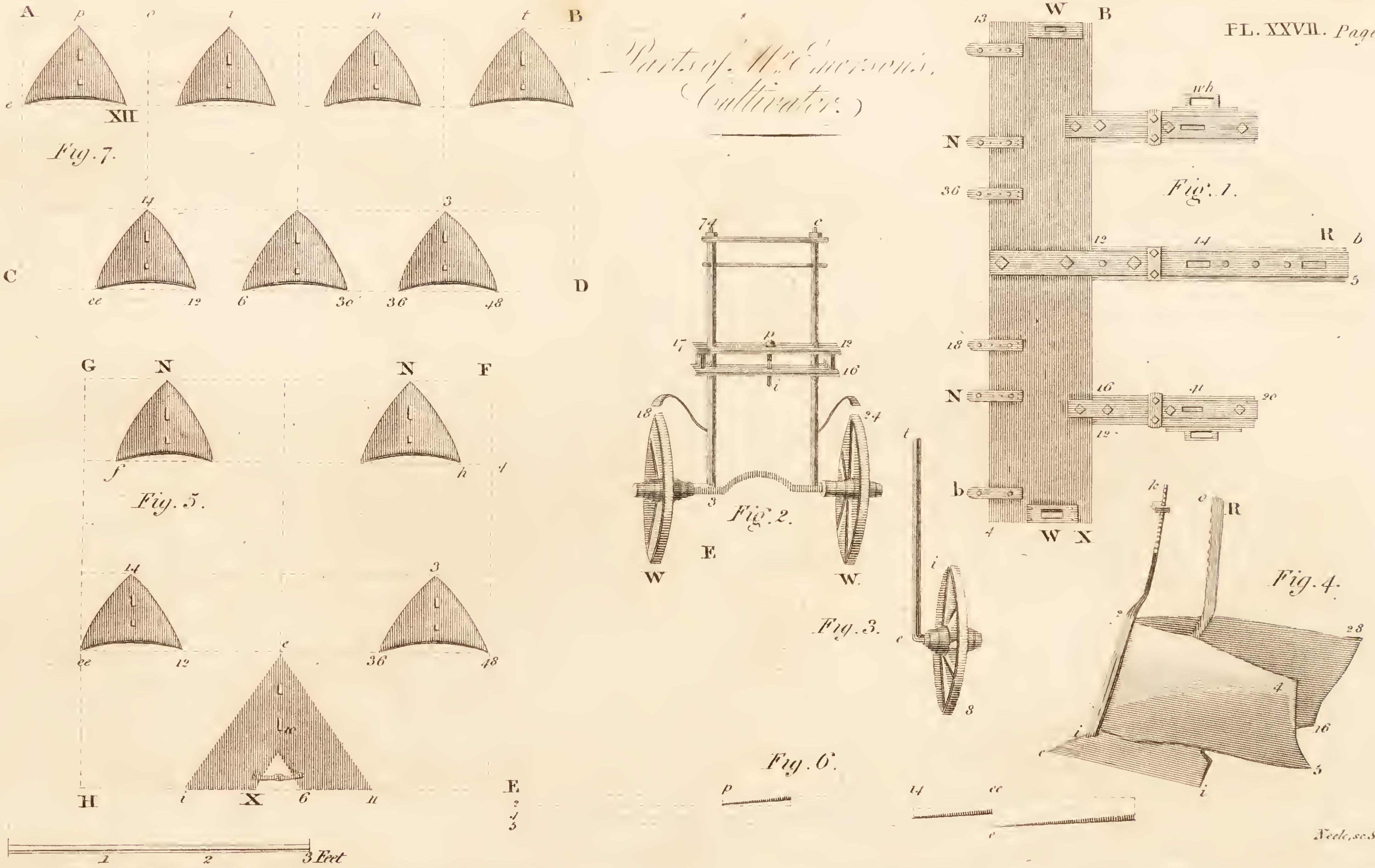
Mr. Emerson's Cultivator.



3 Feet

Neele sc. Strand.

Parts of Mr. Emerson's, (Cultivator.)



Neele, sc. Strand.

	Ft.	In.		Ft.	In	Diameter.	Ft.	In.
b 18,	1	6	p t,	4	6			
i p,	1	6	x 8,	1	9	t 8,	1	6
iv b,	4	6				W,	1	6

The several parts of which are shown in plate XXVII. in which fig. 1. represents the beam, and its irons fixed proper for receiving the shares; W W, places to fix the wheels, as commonly used, with the seven shares. Fig. 7. explains how to set the shares exact. It may at pleasure be varied in the number of shares, so as to use it with three or five, as seen at fig. 5. When the large share is used, to make ridges, put the large share fig. 4. in at R, in fig. 1. and take two of the fore shares out, and remove the other two shares to N N. Fig. 5. shows how to set them, with the great share following them. This share is never used in fig. 7. which is the way it is generally used with six horses (put double): when the great share is used, remove the wheels to W h W h. Fig. 6. represents a section of the shares as they should be set to work, each share being set on a different plane line, besides having each an inclination to point downwards. In the line E *ee*, the earth; *p*, the point of the fore-share, on the line 2, which is two inches deep; 14, the point of the second or following share on the line 4; which is two deeper, making it four inches deep, and thus much of this figure represents the section of setting the shares as most used. But when the great share is added, its point *e*, is to be set on the line 5, which makes it five inches deep. The wheels should be put as high as the ground line E in fig. 6. but may be altered by the notches in fig. 2. and fig. 3. The higher the wheels are fixed the deeper the shares will stir the ground, as seen in this plate.

Twice stirring with this machine prepares the field fit for drilling, for which it appears particularly adapted, as it makes the ground much finer than the common modes of ploughing; besides, in seed-time its expedition may be very useful, as at once it ploughs seven times as much as the common plough of nine inches.

The use of the handle T, as shown in the plate is to turn 74 W, the fore wheels, when wanted to return the machine; the handle T, being lifted out of the iron fork *f*, the fore wheels will turn to the right or the left as may be wanted, but when at work, the handle T, resting in the fork *f*, keeps the machine straight forward. To remove it to another field, the wheels must be let down by notches, to keep the shares up.

Fig. 1.

	Ft.	In.		Ft	In.		Ft.	In.
x B,	5	2	16 41,	1	2	Fig. 2.		
13 B,	1	1	16 20,	1	8	74 c,	1	2
4 x,	1	1	v iv,	0	7	c 12,	1	0
n b,	2	6	o o,	0	4	c 16,	1	4
b 5,	0	5	b 18,	1	6	74 30,	2	6
n 14,	1	2	18 36,	1	6	74 E,	3	3
14 R,	1	2	36 iv,	1	6	W W,	2	1
x 12,	1	0	iv b,	4	6	W 18,	1	6
x 16,	1	4	N N	2	6	18 24,	2	0

	Ft.	In.		Ft.	In.		Ft.	In.
12 17,	1	6	48 4,	2	0	A p,	0	6
i p,	0	6	N F,	0	9	p o,	0	9
Fig. 3.			N N,	2	6	o i,	0	9
r t,	2	0	14 3	3	0	i n,	1	6
W 8,	1	6	ee 12	1	0	n t,	1	6
i w,	0	2	12 36	2	0	e p,	1	0
Fig. 4.			e 1,	0	4	p xii,	1	0
e i,	1	8	e 10,	0	10	e xii,	1	0
e l,	0	4	e i,	1	8	Concave,	0	1
l 2,	1	2	i x,	0	8½	xii 14,	1	2
l k,	2	8	x 6,	0	6	14 12,	1	0
k R,	0	6½	i 11,	1	11	12 ee,	1	0
o R,	0	2	e ee,	2	0	12, 6,	0	6
2 4,	2	0	e 48,	2	0	ee 30,	2	6
4 28,	2	4	f h,	3	6	30 36,	0	6
28 6	1	4	ee 48,	4	0	ee 48,	4	0
36 5,	0	5	Fig. 7.			14 3,	3	0
1 5,	2	3	A B,	5	6	o 14,	2	0
Fig. 5.			C D,	5	6	c ee,	0	9
G F,	4	0	A C,	2	10	p t,	4	6
G H,	4	3	A e,	0	10	e x,	5	6
F 48,	2	10						

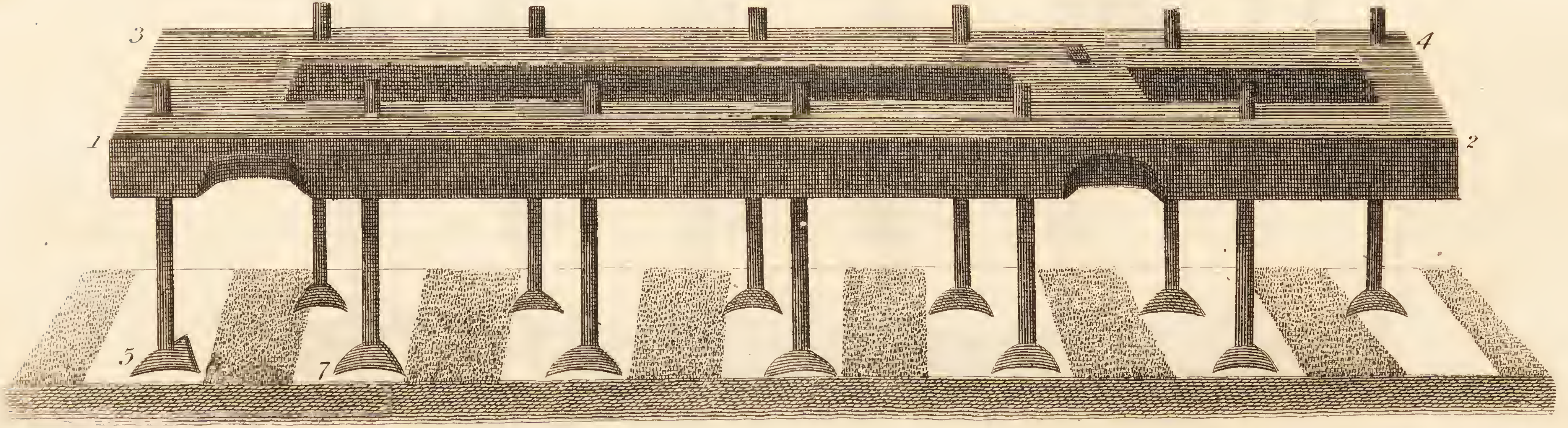
In plate XXVIII. is the representation of a corn cultivator employed by Mr. Rogers in Essex with great success, it is a powerful tool on those stiff soils. And in plate XXIX. is a cultivator for beans, which answers well in the practice of the same gentleman.

The *extirpator* is a machine of this sort, which seems to be used with advantage in some parts of Suffolk, as well as other counties, for destroying weeds, and clearing such lands as have been once ploughed for the reception of the seed. It is drawn by two or more horses, according as the soil is more or less heavy and tenacious, and as the depth required is greater or less. It does much work in a little time. When employed, it may be fixed to the wheels of a common wheel-plough, and be regulated in respect to depth in the same manner.

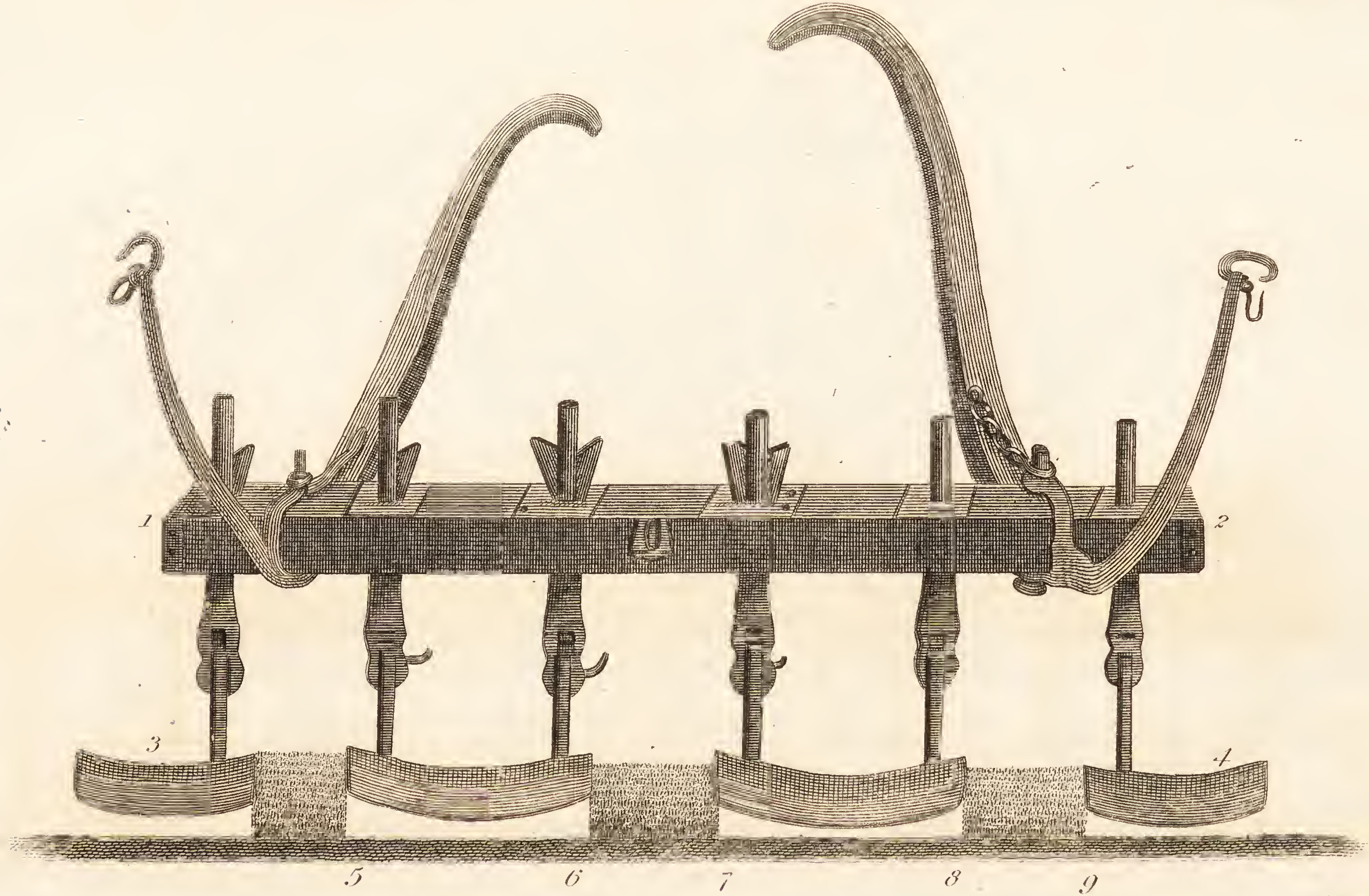
If the land has been once ploughed over and laid a summer fallow, the common way of proceeding with this instrument is to work it twice over with it; the first time about two inches deep, and the second crossways about four inches in depth; which, by afterwards running a common harrow over it, renders it proper for the drill or sowing. Lands ploughed in autumn, and intended for spring crops, may also be well prepared for the seed by this instrument.

At fig. 1. in plate XXX. is seen a back view of the machine when put together ready for work: *a* the shares, eight inches broad and nine inches long, which are fixed to stalks rising ten inches. The distance between them is eleven inches: *b* the hind ledge, six feet long and about four inches square: *c* the fore ledge, five feet and a half long, four inches square; the distance of these ledges is twelve inches: *d* the beam, seven feet long; its elevation is three

(Mr. Rogers's Corn Cultivator)

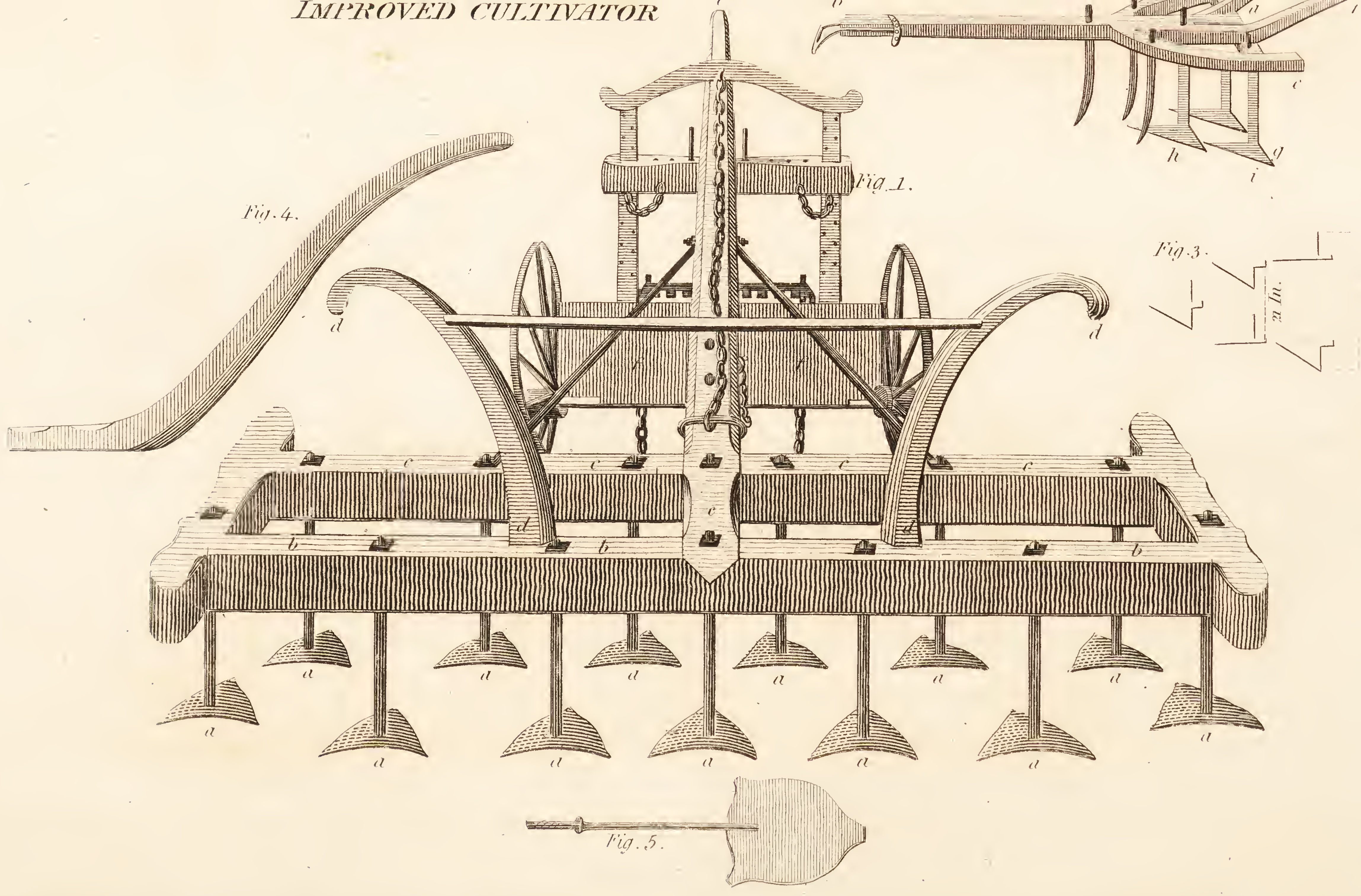


Neele sc. Strand.

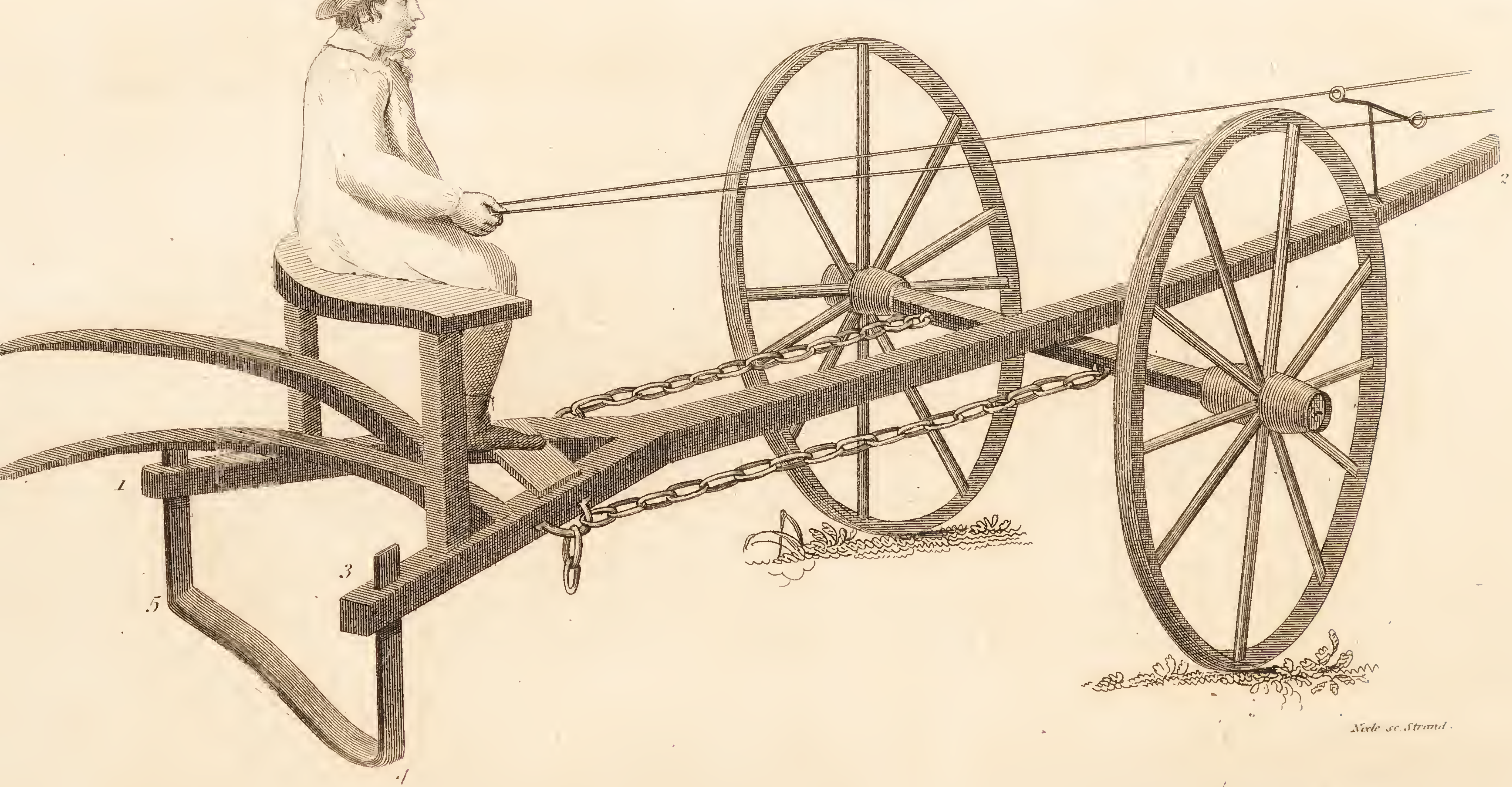


(Mr. Rogers's Bean Cultivator.)

IMPROVED CULTIVATOR



Shim, at Mr. Ruggles's, Finchingfield.



feet three inches. See fig. 4. *c* the handles; fig. 4. is a side view of the beam, and fig. 5. represents a share with its stalk.

The shares in this tool are commonly made about nine inches long, and nearly of the same breadth, being attached to a kind of stem or shank of ten inches in length, at the distance of about twelve inches. It has ledges before and behind; the first of which is about five inches and a half long, and the latter six feet in length, both having the square of four inches; the distance of these ledges from each other is generally about twelve inches. The beam is seven feet in length, having the elevation of about three feet. It has likewise two handles behind. It is said to answer on all lands, and to be capable of being managed by almost any ploughman.

All these kinds of implements may be considered as in some degree appendages to the drill, and may, as has been seen, frequently be applied to the same wheels.

Shims.—These are necessary tools for cleaning the surface of tillage lands after bean or other crops, which leave them in a rough state. They likewise work the fallows well, cutting up all sorts of weeds and trumpery. In plate XXXI. is shown an implement of this sort, in which the driver rides in performing the work when it is necessary. The dimensions are,

			Ft.	In.				Ft.	In.
From	1 to	2	6	6	From	4 to	5	3	0
	1	3	3	3	Diameter of wheels			3	0
	3	4	1	3					

There are several other useful implements of this nature employed in the cultivation of particular sorts of crops, as potatoes, &c. under which they will be noticed.

Drags.—These are tools of a somewhat similar kind, and employed both for the purposes of clearing land and preparing it for putting in the seed. They are made with considerable difference in different parts of the kingdom. The common drag is most generally made use of; but the duck-footed one, with four rows of teeth, is preferable in many cases, as it does its work more effectually. A late writer recommends an instrument of this kind, in which the teeth are fixed in by wedges instead of screws, so that they can be put in and taken out readily, and be set to any depth, as a very useful tool.

Implements of this sort are commonly made of a triangular form, being about seven feet in width behind, and having thirteen or fourteen teeth in each of their sides, set in such directions as to cross each other, being fastened at top either by screws or some other convenient means. Where such implements are made use of occasionally as scarifiers, the teeth should be wedged in somewhat in the manner of coulters, and a proper set must be had for the purpose.

An useful *couch-grass drag* has been delineated by Mr. Amos in his Treatise on "Agriculture and Planting," which he thinks of vast importance in cleaning land infested with such sorts of grass,

as it tears it up to the surface, without ploughing the land or breaking the roots, and it can with two men and four horses drag fifteen acres in one day.

It is added, that when all the couch-grass is collected by the operation of the common harrow, after the second ploughing has been given, is the time for using this machine. He advises us to drag the land the lengthway of the ridges, then to harrow it once or twice, at the same time collecting the couch-grass into rows as much as possible with the harrows: rolling the land and then gathering the couch-grass into heaps by the couch-grass rake, (hereafter described) and to burn it: and if the land is very full of couch-grass, it may be proper to drag it across, then harrow and roll as before, and afterwards gather the couch-grass into heaps again by the rake, and burn it. Further "to plough the land a third time; and if any more couch-grass turns up to barrow, drag, roll, and rake it once or twice, before the fourth ploughing. When the coulters gather much of the couch-grass, they should be cleaned occasionally; and in cleaning them, one man should lift up the side of the drag by one of the handles, while the other man knocks the couch-grass off the coulters with the other handle."

Harrows.—Implements of this sort are not only useful, but particularly necessary, in the practice of husbandry, both for covering the seed and preparing the land for its reception, though they have yet undergone but little improvement: the chief circumstances in which they have been rendered more convenient are in the position and mode of fixing in the teeth, the direction of the bulls, and the manner in which the horses are attached to the implements. It must be evident to every one the least conversant with the business of harrowing, that no one harrow, whatever its construction may be, can be suitable for every sort of soil, or can act with equal effect on such grounds as are rough and smooth, or firm and loose; they must be adapted to the nature of the land and the particular purposes the operator has in view. In the lighter sorts of ground, a light harrow with short tines or teeth may be sufficient: but in strong and tenacious soils, or such as have been newly broken up from the state of old léys, or from a state of nature, such as moors and wastes, a harrow which possesses much greater weight and has longer teeth is to be preferred; and even where the land is rough and not easily reduced, as in fallowing strong clays, two harrows fastened together may frequently be necessary, in order to fully reduce and break down the cloddy soil. For these purposes, too, it is better, especially where the land is tenacious and abounds with the roots of weeds, that the harrow should not be too thickly set with teeth; as in such circumstances, where it has a number of teeth, it is not only soon choked up and prevented from working, but confined too much to the surface, by which the soil is very imperfectly reduced and broken down.

Improved common harrows are much employed in many districts, being frequently made use of in first reducing the uneven surface left by the plough. And *double harrows* of the same kind, as well as *jointed brake barrows*, to which handles are fixed behind for the pur-

PL. XXXII.
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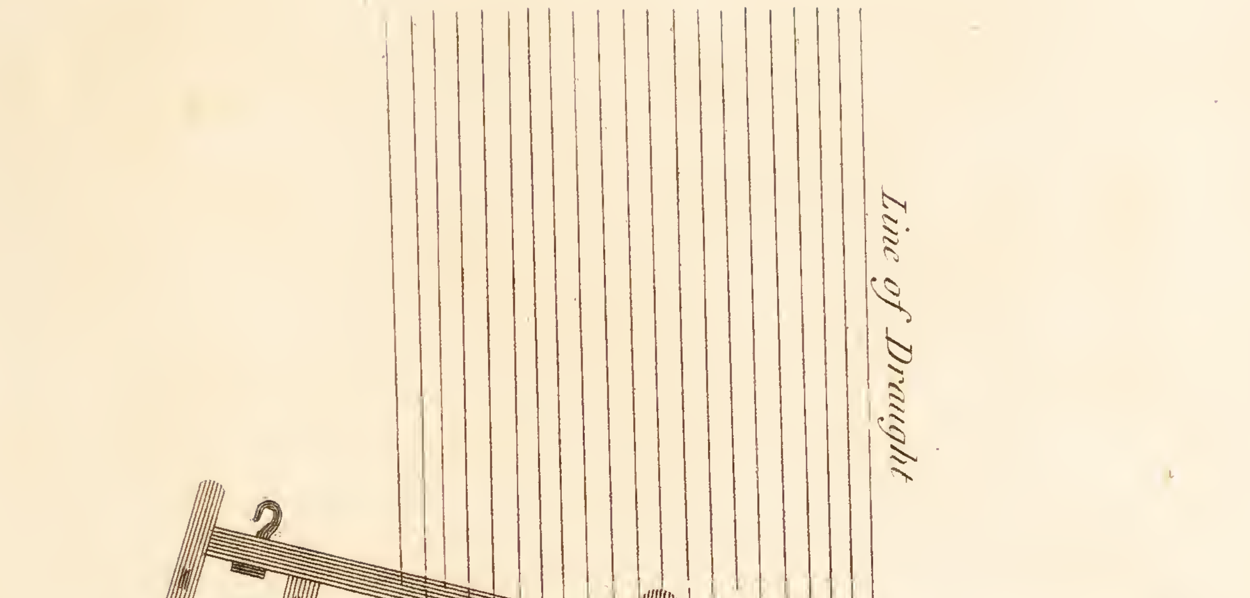
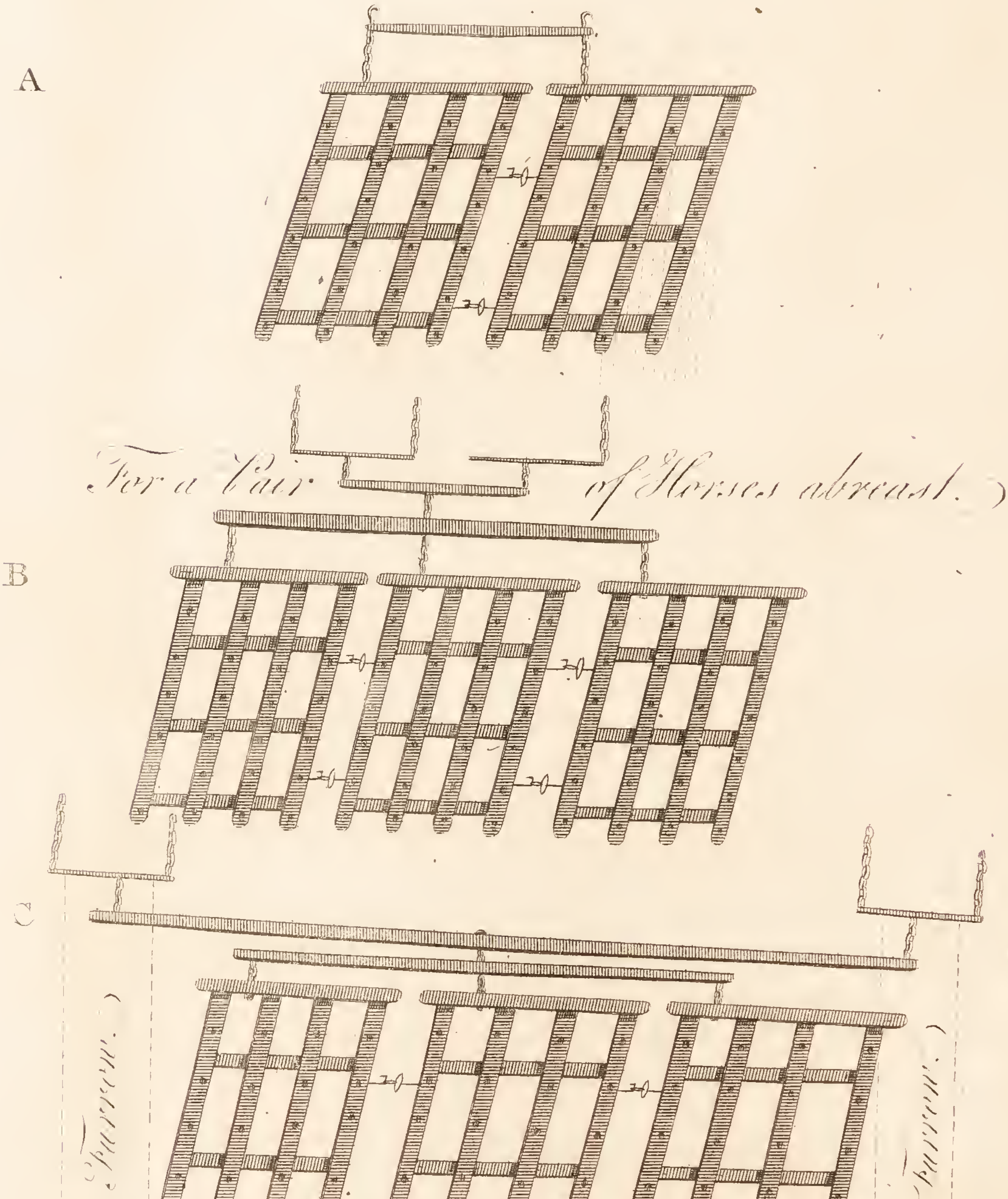


Scale ½ Inch to a Foot.

Neele sc.

Leicester & Rutland. *Mr. Hanford's Implements.*

For 1 Horse for Seeds.



Neele sc.

pose of raising them occasionally when it may be necessary to clear them from roots, &c. are likewise in common use for the more heavy sorts of work.

The harrow made use of in Berkshire is probably the most applicable to general purposes of any at present employed. An useful harrow is seen at fig 1. in plate XXXII. which is somewhat of this kind; and in plate XXXII. harrows for different uses are represented. They are made by Mr. Hanford of Leicestershire, and are found to answer well.

In performing the business of harrowing, much time is often lost in turning at the ends of the ridges, where two or more common harrows chained together are employed, by their hitching on each other, or turning over, and requiring the driver to stop in order to put them right again. To remedy this inconvenience, harrows have been contrived with running bulls, a mode of construction which has been found to answer well. This inconvenience may however be corrected in a much easier and less expensive way; as by fastening the instruments to each other by means of proper hooks and eyes, or what are termed coupling irons in some places, by which contrivance the different harrows rise and fall at the same time, and are kept from ever getting upon each other. The position of the teeth, so that they do not move in the same line of direction, is likewise an object that has been attempted to be effected in different methods; but the most simple and expeditious is probably that of having the harrow so formed, as to be some inches narrower before than behind, and at the same time to be capable of being set to different widths, so that the distance between the teeth may be regulated by increasing or diminishing the difference between the fore and the hind parts of the harrow. Common harrows may likewise in some measure be prevented from having their teeth moving in the same directions, by being so yoked or attached to the horse as to move on the land somewhat in a diagonal line. In the construction of all the larger sorts of harrows, it is of the utmost importance that the tines, or teeth, have a slight inclination forwards, and in all kinds of these implements that no two of them move exactly in the same line of direction. By these improvements, harrows are capable of doing a great deal more work, of keeping more closely to the ground, and of cutting as well as tearing up more effectually such weeds as they meet with.

It is a good practice to have the teeth, at least of large harrows, fastened into the bulls by means of nuts and screws, in such a way as that they can be removed with facility when necessary; or perhaps a still better method is to have the heads of the teeth made square, and put upwards into the bulls, having long holes in the parts that come above them, into which square wedges may be put in order to keep them fast and prevent their being lost.

Harrows are also sometimes constructed with teeth of unequal lengths; the first row of tines, for instance, being a quarter or half an inch shorter than the second, and so on. These harrows have been said to do more work, and to be more readily cleansed of weeds and other substances, by which they are liable to be choked up.

Harrows formed in this way are common in some parts of Devonshire, and have lately been introduced into Leicestershire with success by Mr. Handford. This kind of implement is made in different ways, and with different number of bars or bulls, but from three to five is the most common, and the quantity of teeth vary in the same manner.

A harrow invented by Mr. Grayburn, and represented in the Report of the Agriculture of Lincolnshire, seems also to possess considerable merit, especially for lands in which the ridges are narrow and round, as it is contrived with a standing joint in the middle, which admit of its being more completely applied to the land.

There is a harrow designed by Mr. Knight, which is likewise well contrived for obviating the difficulty and inconvenience of turning, as well as lessening the stress and draught of the horses, as it is constructed with wheels; but it would seem to be much too complex and expensive in its construction for general use In many kinds of land it must also be extremely liable to be prevented from working, by the wheels being clogged and filled up.

The *four-square harrow* is employed on new-inclosed and broken-up lands in the midland districts, where the ground is very uneven, with great advantage. In plate XXXIV. is shown an *improved harrow*, with *running bulls*. By this contrivance the harrows are prevented from riding on each other, or turning over at the ends of the ridges in returning. They are made by Mr. Handford, and found to answer well in Leicestershire. The price about 3*l*. 3*s*.

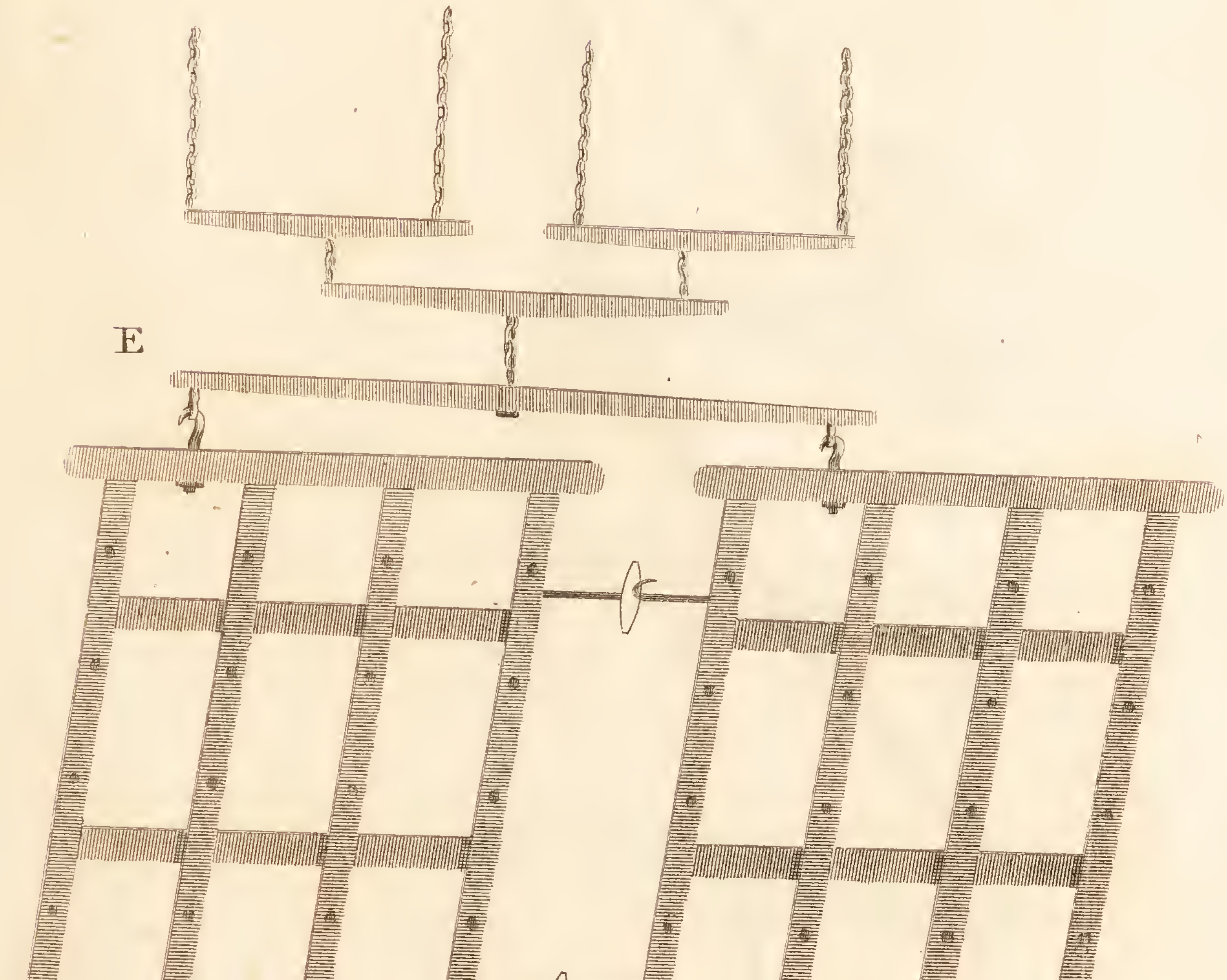
In plate XXXV. is given the representation of an *iron harrow*, which Mr. Young has had constructed of that metal from finding that those formed of wood are often liable not only to fall to pieces, but to be too light for some sorts of work. Every tooth screws through a double frame separated by iron washers for greater steadiness, and there are handles fixed for the ease and convenience of lifting or pressure. These harrows are found to answer perfectly well. The price is 6*l*. 6*s*. It is observed that all harrows should have handles, that the clods, or tufts of weeds, may not be dragged along, to save the trouble of raising them in order to clear them. Any smith may construct a pair from this representation, varying the shape according to circumstances.

For putting grass seeds into the ground, a small light harrow with short teeth is mostly to be preferred.

A *bush-harrow*, or that sort of harrow which is formed by the interweaving of some sort of bush-wood into a kind of frame made for the purpose, and raised in the fore part by two small wheels, may frequently be employed for the same use, as well as for harrowing-in dung, or other earthy matters, into grass-lands.

Harrowing, in general, is by much the best performed by driving the horse or horses by whip reins of sufficient length to permit the person employed to walk after the harrows. By this management he can clear the harrows as occasion may require, and proceed in his business with greater dispatch. It is now a pretty general observation among the intelligent cultivators of land, that the business of harrowing is more effectually and more advantageously performed

Mr. Hanford's Implements &c.



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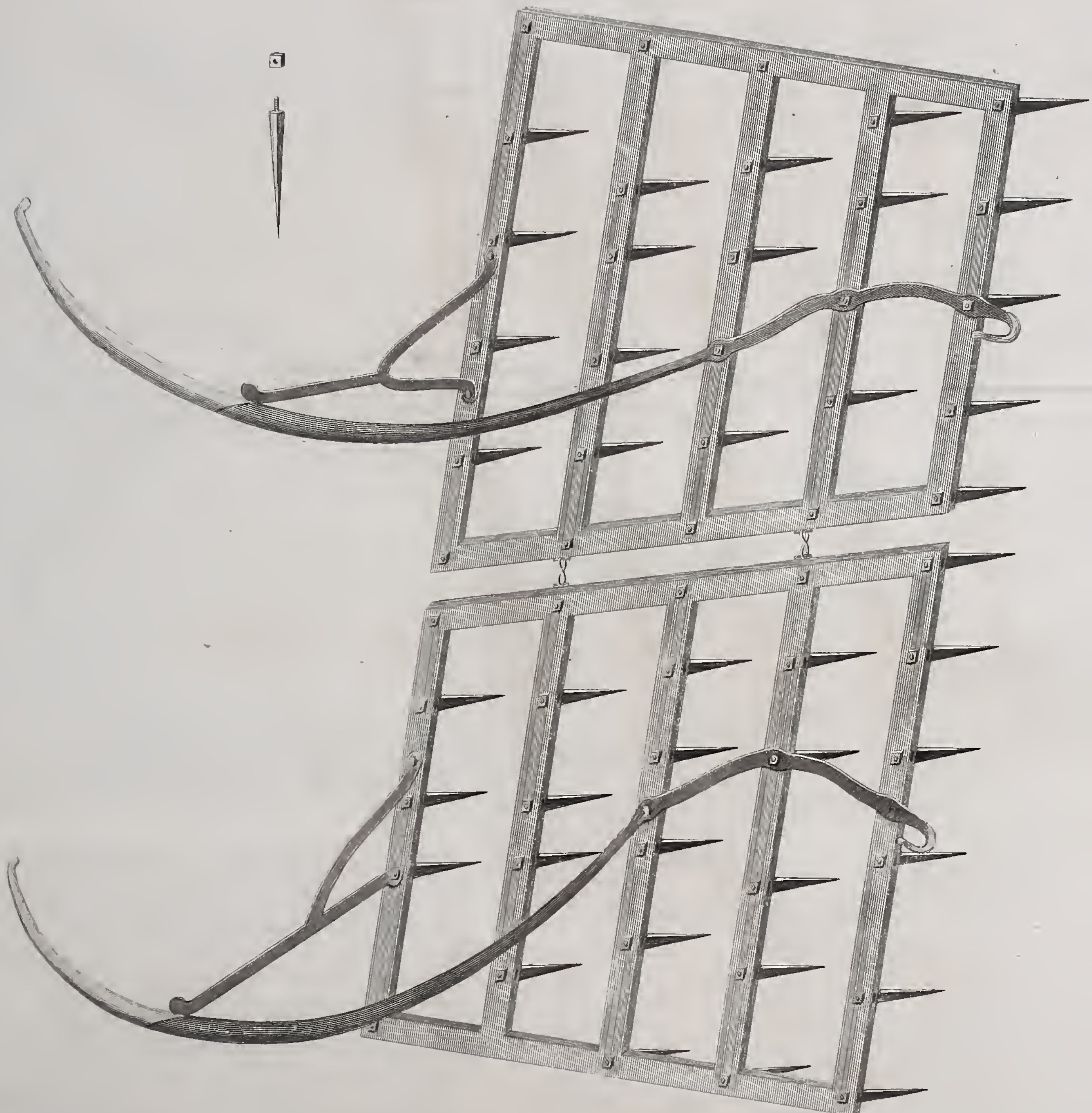
IMPROVED IRON HARROW.



ROLLERS.

Fig. 1.

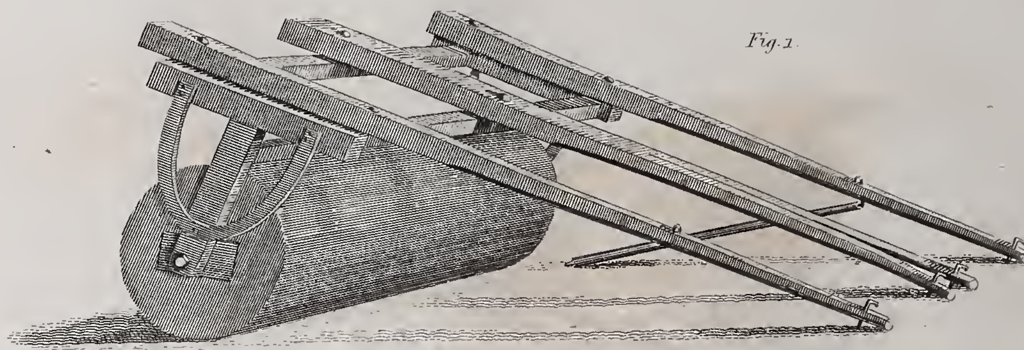


Fig. 2.

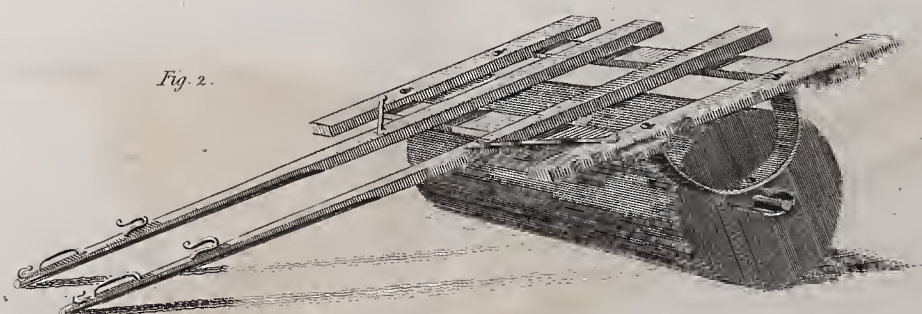
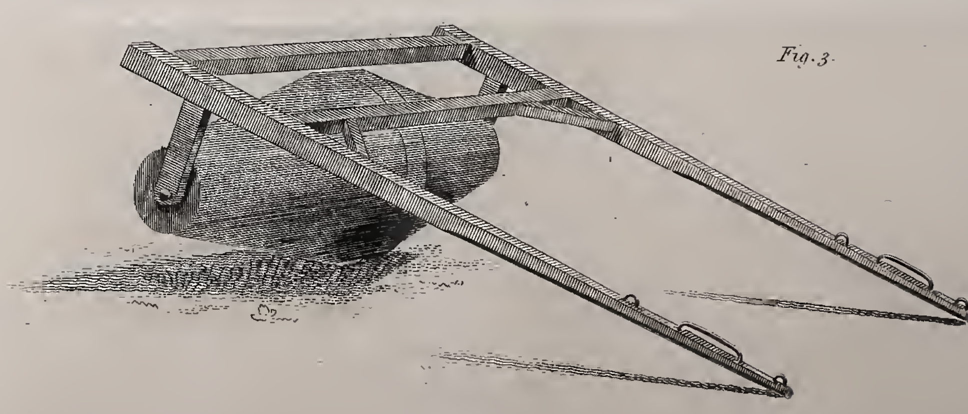


Fig. 3.



by single-horse harrows than by such as require two horses. In the attachment of these implements to the power which is to draw them, the common method is by a strong sort of staple fixed to one of the corners of the harrow by a bolt; but a mode which appears more advantageous is that of connecting the muzzle with a perpendicular pin at one corner of them.

ROLLERS.—These are most commonly made of wood, cast-iron, or stone, according as one or other sort of material is most ready and easy to be obtained; and are of different sizes and weights, in order to suit different purposes. In constructing heavy rollers, the workmen should be careful that they have not too great a diameter, whatever the material be of which they are formed, as the pressure is diminished where the implement is of very large size, by its resting on too much surface at once, except an addition of weight in proportion be made. By having the roller made small, when loaded to the same weight, a much greater effect will be produced, and a considerable saving of expense be made in the construction of the implement. All the larger sorts of rollers should have double shafts, in order that they may be drawn by two horses abreast; and such as are employed for arable lands should have a scraper attached to them. This addition saves much time, and prevents the driver the trouble of constantly scraping the machine, especially in wet seasons and clayey tenacious lands. Strong frames are also necessary for rollers, so that proper weights may be put upon them; and open boxes or carts placed upon them may sometimes be requisite, especially when for grass-lands, in order to contain any additional weight that may be thought proper, as well as to receive stones or other matters that may be picked up from the ground. Pieces of wood or stone, as heavy as a man can lift, are the most suitable substances for loading these implements with, where they have not the advantage of boxes.

At fig. 1. in plate XXXVI. is the representation of a *common grass-roller*, employed for rolling hay-lands in the county of Middlesex. It is drawn by three or four horses abreast.

The *common rollers*, such as are mostly used for rolling wheat in the spring, and grass seeds, are generally about five or six feet long, and from fifteen to thirty inches in diameter; but those employed for flattening one-bout ridges, in order to prepare them for drilling turnips upon, are commonly shorter and of much less diameter.

At fig. 2. in the same plate is a common *stone roller*, made use of in many of the northern districts for rolling arable lands.

Spike-roller.—This kind of implement is formed pretty much in the same manner as the common roller, except in having the addition of a considerable number of spikes made to it. These rollers are principally employed where the soil is stiff and cloddy, in order to reduce and break down the lumpiness, and bring the land into a fine state; and, when well constructed, are in many cases good and effective tools for the purpose.

Mr. Amos, in his "Minutes on Agriculture and Planting," has given the representation and description of a most useful roller for reducing strong, stiff, stubborn, clayey soils, which is constituted

of the plain and spike rollers, but which may be employed either in their compound or simple state.

"Its powers," he says, "are wonderful in pulverizing such land; it gives," continued he, "the farmer a command over dry seasons, and enables him to sow his spring and fallow crops in proper time. It enables him to clean his arable land of weeds, whether they are propagated by the root or by the seed. By passing this roller over the land once, twice, or thrice, and drag-harrowing it between every rolling, it will be sufficiently fine for every purpose wanted. When the clods are reduced so small that the spike-roller can make very little more impression upon them, the plain roller and drag-harrow may be used to advantage. This roller is likewise of very great use," he observes, "in restoring degenerated sward, as will be seen hereafter." In plate XXXVII. is the representation of a *double-spiked roller*, which is employed with great benefit in the midland districts of the island.

Drill-roller.—The Norfolk farmers, we believe, have the merit of this invention. It is formed with rings of cast-iron round that part which constitutes the roller, at small distances from each other; by which means drills are made in the land, and the intermediate parts rising into ridges, the corn of course chiefly falls into them, being thereby better deposited in the earth, and better covered than it would have been if sown upon the furrows without them. The main object of this practice is the saving the expense of dibbling, though it is not by any means so good a practice. On light grounds, where pressure is required, it may, however, be employed with great advantage. It may also be made use of in dry seasons for reducing stiff clayey lands which are under fallow; for which purpose it is, perhaps, a more efficient implement than the spike-roller. Where this roller is made use of, the seed is sown broad-cast, and covered by means of a small or bush harrow.

At fig. 3. in Plate XXXVI. is exhibited the plan of a *furrow-roller*, invented by Mr. Pinchard, for rolling the furrows in hilly and other lands, where the common rollers cannot be employed. It is remarked in the Essex Survey, that the bellying roller is common in many parts of the kingdom; but that the *concave roller*, smallest in the centre, and swelling to a large circumference at each end, is a new invention. It is much approved in this district, being made to suit in length the breadth of the stitch or ridge. It is shown on its sledge in Plate XXXVIII. The dimensions of which are

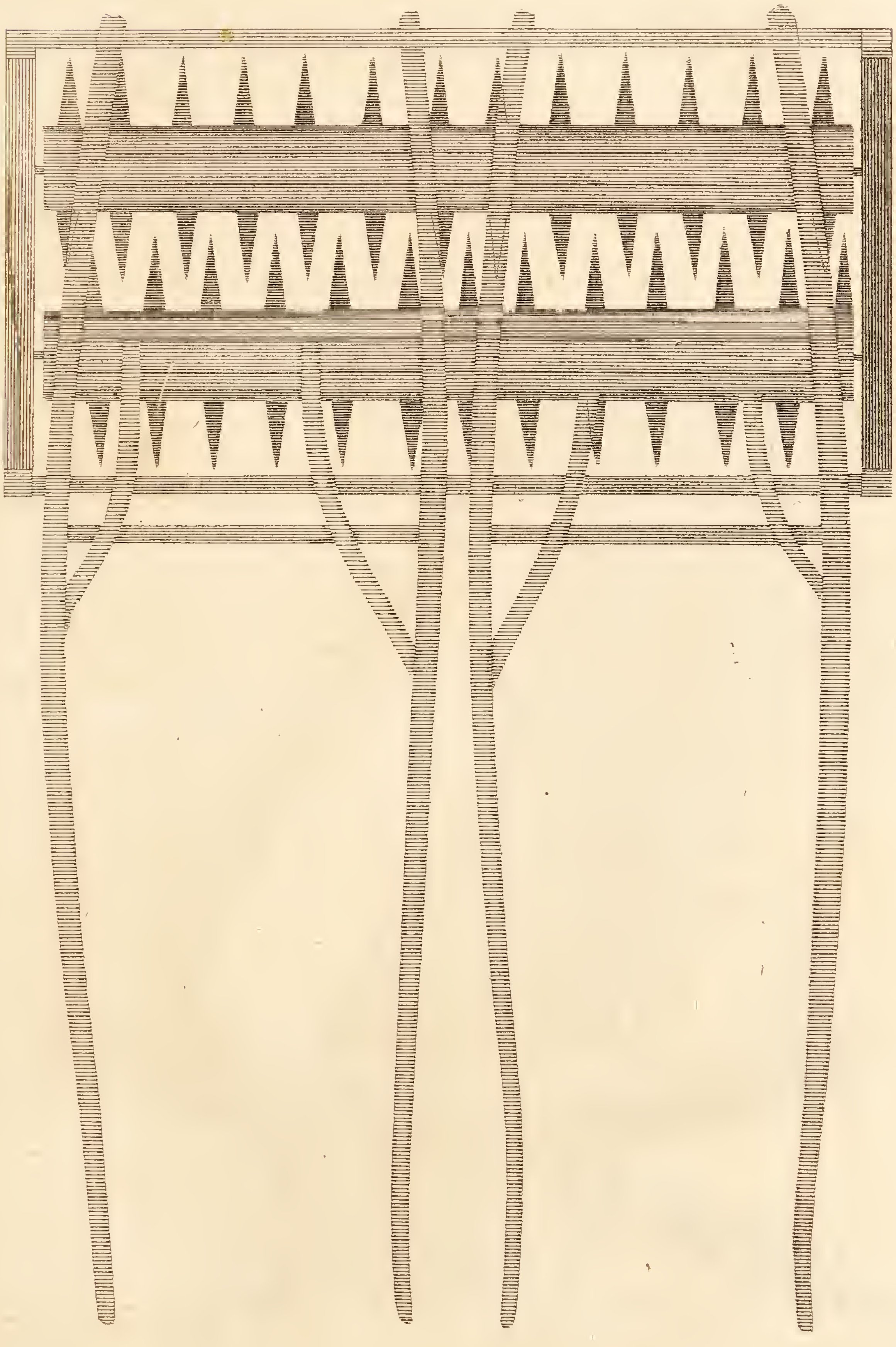
		Ft.	In.
From 1 to 2		4	3
3	1	7	9
2	4	7	9
3	4	4	3
5	6	7	2

	Ft.	In.
Diameter at 5 and 6	1	10
Ditto at 7 the concave	1	4
Circumference at 7	4	

A *jointed roller* has been contrived by Mr. Tweed of this county, which is found extremely useful by preventing poaching, in consequence of the horses going in the furrows only. All his clover land for drilling wheat is rolled by it.

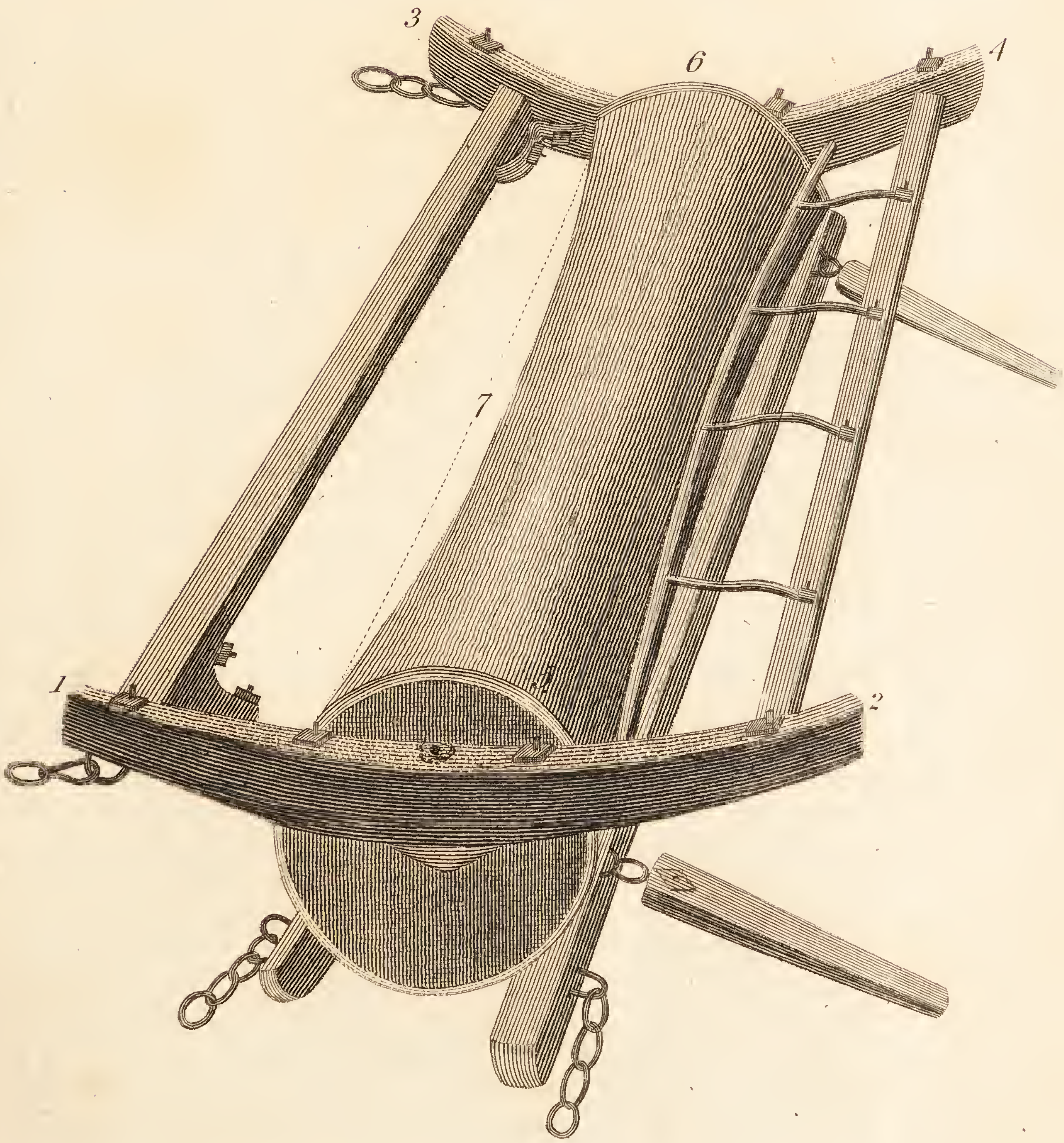
PL. XXXVII. p. 48

The double spiked Roller.



Plate, XXXVIII.
Page. 48

Concave Roll on its Sledge.



The wooden rollers which are frequently, and with great propriety, had recourse to for rendering grass and pasture-lands smooth and even, are in many places much too large to produce the powerful effect they are intended to have, unless a proportionate increase of weight were added, for the reasons which have been just given. They should therefore be made less in size, and be loaded, in order to produce the great degree of pressure which is wanted in these cases. That which is described above has been found very effective in practice in the hay district where it has been employed.

As in turning at the ends of ridges or fields, rollers, from their not moving upon their axis, but being drawn along the surface of the ground, are liable to tear it up, and make deep holes and depressions before they come again into the direct line of draught, and are not brought round without great exertion in the team; it has been attempted, in order to obviate these inconveniences, to construct rollers in two pieces, and by the division in the middle to enable the different parts to twist round on their proper axis, one forward and the other in a retrogade direction. When formed in this way, the cylinders are best when made of cast iron.

In the rolling of ground, especially when such rollers are employed as are composed of one piece only, it is by much the best method, where it can be accomplished to go round the whole field in somewhat a spiral direction, and by that means keep continually proceeding without the necessity of making short turns; and in rolling down grass seeds with corn crops, this mode is in general to be preferred: but grass-lands may be rolled in any direction, though the mode of rolling ridges separately is evidently more troublesome than that of crossing them.

The proper management of different sorts of land in this respect will be more fully considered afterwards.

Implements used in the Culture of Hops.—In preparing grounds for the reception of hop-vines, and in keeping them clean and free from weeds during their growth, several different implements are employed. The spade and the common hand hoe are, however, in some places the chief tools that are made use of, though they obviously require much time, and consequently increase the expense of the cultivator.

Hop-shim.—This implement is constructed with a frame, somewhat in the manner of the common wheel-barrow, and has feet or teeth which cut up and drag out such weeds as may be present, at the same time that they pulverize and prepare the ground. Mr. Boys, in his valuable Report of the Agriculture of the County of Kent, also observes that this implement may be advantageously employed for clearing summer-fallow from weeds. When well made it costs about two guineas.

Hop-nidget.—This tool is likewise formed of a triangular shape, and of different sizes, according to the distances of the alleys in which it is to be made use of, with cross bars or beams, in which are fixed a number of hoes in proportion to the breadth of the intervals between the rows of hops, so that its hinder part, which is the widest, may pass without doing any mischief to the binds on

each side. The hindermost beam has fixed to it a pair of handles, by which the machine is directed in its operation.

The implement is drawn by one horse managed by a boy; and two acres may in this way be cleansed in a day. Care should however be taken when using it, that in finishing, the alleys should be all crossed in the same direction, in order that every part of the surface, except the spaces which the hills occupy, may be cut over. The hills are to be afterwards rendered clean by means of hand-hoeing. It will be necessary to continue the use of this instrument as occasion may require, until the branches of the hops are put forth in such a manner as to prevent the horse from going along the alleys. By this means hop-grounds may be kept clean and in order at a much less expense than by hand-hoeing, or even digging them in the summer.

The principal circumstance to be attended to in the management of the nidget, is that of guarding against its damaging the binds by coming too near the poles.

Hop-barrow.—By some hop-planters this tool is used after the nidget, for rendering the ground still finer; it is constructed nearly in the form of the nidget, but with a small wheel in the front, in in order to go round at the ends of the plantation more readily. A pair of handles are fixed on behind, by which it is guided in the alleys, and kept from bruising the binds, by the person who holds them. Implements of this kind, when properly made, cost from thirty to forty shillings.

Mr. Middleton, in his report of the county of Middlesex, also speaks of an instrument, in use by Mr. Maynard, for cleaning hop-grounds, which resembles the snow-plough; in shape it is an equilateral triangle, the sides of which are four feet long, and the front ones shod with old scythes; the whole being strongly framed, in order that it may be loaded when employed. He observes that "by drawing it once in a place, in the intervals between the rows, it renders them perfectly clean, and as smooth as the well-rolled walk of a pleasure-ground, and earths up the rows by the same operation, which, about ten days afterwards are easily made into hills with spades."

Hop-peeler.—The peeler is made use of for forming holes for the hop-poles; it is of a sort of iron crow, with a wooden handle across at the top, and made thick and tapering, in order to remove the earth sufficiently for the insertion of the end of the poles.

Hop-dog.—This is a kind of lever, made of a long piece of good wood, with a fixed fulcrum, to the lower end of which is fastened a strong piece of iron with teeth, which grasp the lower end of the hop-pole firmly, and by the action of the lever wrench up the pole.

Thrashing-Machines.—The thrashing of corn by means of machinery has been long in use in the northern districts of the kingdom, and mills of this sort are now becoming general in most parts of the country; and upon arable farms of considerable extent they cannot but be highly advantageous, as they save much labour and expense. In the making of these machines, attention should

always be had to the size of the farms, or rather the quantity of grain that may be grown on them, and the mill proportioned accordingly. They are mostly constructed on the principles of the flax-mill, and are moved either by water or horses, the first by far the best method where it can be had; the grain by these machines being, as it were, swingled out of the ears by means of beaters which are attached to a cylinder that moves with very great velocity. Since the introduction of these machines, many improvements have been made on them; a screen has been added for the grain to pass through into a winnowing-machine, and a circular rake to remove the straw from it; as before this addition the straw was forced out from the beater upon the upper barn floor, and required much time and labour in shaking and putting into order, which by this contrivance is saved. In working these mills, four persons are commonly necessary; one takes the sheaf from the stack, another places it ready for the third, who is to feed the mill, and the fourth removes the straw to prevent its collecting in too large a quantity. It has been objected to these machines, that they do not thrash some sorts of grain clean; this has been particularly the case with barley. It is however, observed by an intelligent writer, that the circumstance on which the good thrashing of this kind of grain depends, is the iron covering under which the beating wheel, having six beaters, moves: in some machines this is fixed, while the beating-wheel is capable of being raised or depressed at pleasure; but a recent improvement is to render the iron roof moveable and the wheel fixed; and the iron is placed so near to the beaters that the grain is rubbed, as well as stricken out of the ear. In some machines of this sort the beaters are a little rounded; but it is probably a better practice to have them of the common flat form.

In some large mills of this kind the rollers take in about three hundred inches of grain in a minute. The medium length of the straw being estimated at about thirty inches, and supposing half a sheaf to be introduced into the machine at a time, the whole sheaf will be equal to sixty inches, and the machine when supplied with a middling quantity of water will thrash five sheaves in a minute. But in respect to the performance of these mills, much must depend on the attention with which they are fed, as a small neglect in this point will make a very considerable difference in the quantity of work done.

An excellent description of a mill of this nature is given in a late publication, in which it is remarked, that in such mills five people are commonly necessary to keep the work going on without embarrassment; but that this depends greatly on the construction of the machine, some of them being so contrived that the work can be performed with much fewer hands. The manner in which these people are employed is this; One finds constant work in carrying the sheaves to the man who feeds or puts the unthrashed corn into the machine, and in loosing the bands; another is required to feed the machine; a third to carry off the straw; the fourth to attend the fanners, and lay aside the cleaned grain; and a fifth, where horses are made use of, to take care that they go regularly; and tha. by

means of five men and four horses they will thrash at the rate of five quarters in the hour on a medium, and when the crop is rich, and easily thrashed, considerably more: consequently if a thrashing-mill was to be employed for a whole day, or nine hours, it would thrash forty-five quarters; but in that case it would be necessary to employ two sets of horses. The expense is calculated in this manner:

	£.	s.	d.	
Hire of eight horses, at 2*s.* 6*d.* each per day	1	0	0	
Five men's wages, at 1*s.* 6*d.* each,	0	7	6	—1 7 6

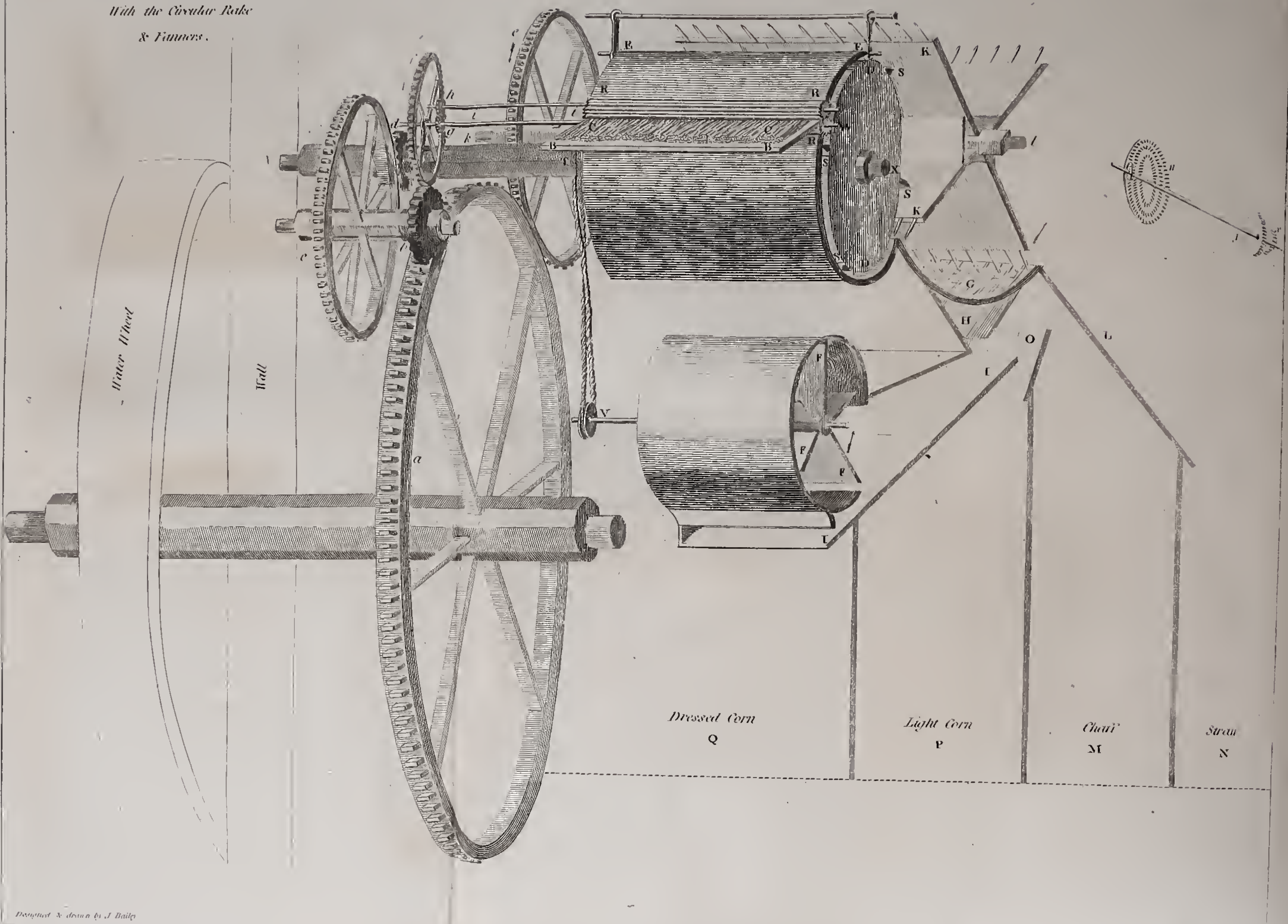
In this account, the hire of the men and horses is, it is conceived, charged at the highest rate, and that the expense of thrashing forty-five quarters of grain would cost 1*l.* 7*s.* 6*d.* or about 7*d.* each quarter But that taking the average expense of thrashing forty-five quarters of grain with the flail, throughout the whole kingdom, including an equal proportion of all kinds, it cannot be, it is supposed, estimated at less than 3*l.* 7*s.* 6*d.* or 1*s.* 6*d.* each quarter, which makes a difference of about 11*d.* each quarter *. It is also further observed, that since the introduction of these mills, the grain is thrashed by the ordinary servants on the farm, and without in any material degree obstructing the operations in the field; farmers in general employing their men and horses in this business in bad weather, when other operations cannot be carried on.

The whole expense of constructing a thrashing-mill, including the building of the shed for covering the great wheel, does not, in almost any case, exceed 100*l.* The ordinary annual repairs may, one year with another, amount to 5*l.* which added to the interest of the prime cost, makes the yearly expense 10*l.* a sum for which any quantity of grain, however great, that may be supposed to grow on one farm, can be thrashed, and that to in a manner much superior to what can be done by manual labour. The expense either of erecting these machines, or of keeping them afterwards in repair, must be considered by every intelligent occupier of a corn-farm as a secondary object, when compared with the advantages that are derived from them: such as the performing of the operation at less than half the ordinary price, and affording the farmer the means of securing his grain from being embezzled: besides, the saving, in regard to superior clean thrashing, as has been now well ascertained, is not only more than the annual expense of repairs, but so great as, on a farm of considerable extent, to reimburse the farmer for the whole of his expenditure in the course of a few years. Therefore, considering the increasing scarcity of labourers, and the recent great advance in the rate of labour in all the better cultivated parts of the kingdom, the introduction of thrashing-mills into common use cannot but be highly beneficial.

There is however, one difficulty in the introduction of thrashing-mills into the southern parts of the kingdom, which arises from the manner of barvesting all kinds of grain, except wheat, which cannot probably be easily removed; as the corn, in order to be clean

* These estimates are considerably too low for the present price of labour.

A View of the THRESHING MACHINE
Erected at Chillingham, 1789.
With the Circular Rake
& Fanners.



Designed & drawn by J. Baily

hrashed, should be put into the machine as straight and regular as possible. For while the sheaves, after being loosened and spread on he board, so as to be easily taken in by the feeding rollers, are passing between them, they keep the straw steady, by which means the strokes of the beaters or scutchers operate with more force and effect in separating the grain from the ears; whereas, if the unthrashed corn goes in sideways or irregularly, the thrashers can have but little power upon it. This would, no doubt, frequently happen in thrashing corn which has been mowed with the scythe, and which is harvested in every respect like hay; so that, unless the unthrashed grain be put into the mill in small quantities, it is almost impossible that it can be completely separated from the straw.

But though, when the size of the machine is considerable, the expense of erecting it may be from eighty to one hundred ponnds, according to situation and materials, smaller ones may be erected at much less, as from thirty to fifty pounds. Those constructed by Mr. Asbey, at Blyborough in Suffolk, which thrash all sorts of grain in a perfect manner, cost, for such as are fixed, one hundred, and such as are moveable, one hundred and fifty guineas. Mr. Perkins's, of Stockton-on-Tees, may however be had in its improved state for thirty-five pounds.

In plate XXXIX. is the representation of a powerful thrashing-machine, in which B B is a horizontal board or table five feet long by three feet four inches broad, on which the corn CC is *evenly spread*, and presented to the cast metal fluted rollers RR (four inches in diameter), which take it regularly in, and by their weight and sharp edges hold fast the straw while it is struck or thrashed out by the pieces of wood SSSS, fixed in the cylinder DD, and projecting three inches from its surface. This cylinder is made with strong arms, on which are fixed the pieces of wood, and cased round with narrow inch deals; the whole secured from flying off by strong iron hoops surrounding them at each end; the former are covered with plate iron, to prevent their wearing. These, when they strike the corn, move in an upper direction, RE, with great velocity, and throw the corn as it is thrashed, and the straw as it leaves the fluted rollers, against the circular rake KK, and upon the wire skreen G, from whence the straw is taken by the rake, and delivered upon the sloping board L, down which it slides to the floor N, while the corn passes through the skreen G into the hopper H, and from thence to the inclined board I; but in falling from H to I a strong current of air, raised by the fanners FFF, blows the chaff over the sloping board O, and the light corn against it, which falls into the space P, and the chaff into M, while the good grain slides down the inclined board II, to the floor at Q, from whence it is taken and put into a second winnowing-machine, in which are placed proper riddles to suit different kinds of grain. This second machine is moved by a rope going over a pulley, fixed in the axle T, and is set a-going or stopped at pleasure, by a stretching pulley, as occasion may require.

But where the situation will admit of the board II being placed about four feet from the floor, the second winnowing-machine may

be placed directly under it, and save the trouble of lifting the corn. The whole is put in motion by an overshot water-wheel fourteen feet diameter, which makes from five to six revolutions per minute, according to the supply of water: on the axle of this water-wheel is fixed a large spur-wheel *aa*, of 160 cogs ($152\frac{1}{4}$ inches diameter), which drives a cast-metal pinion *b*, of 16 cogs (15,28 inches diameter), on the axis of which is placed another spur wheel *c*, of 63 cogs (60,1 inches diameter), that drives the cast-metal pinion *d*, of 16 leaves (15,28 inches diameter), on the axis of which is fixed the cylinder DD (four feet diameter and five feet long, with the four projecting pieces of wood, SSSS, that thrash the corn as described above. The large spur wheel *aa* also drives the light spur-wheel *c* of 63 cogs (60,1 inches diameter), fixed on the axis *k l* of the rake for taking away the straw.

The *rollers* are moved by the pinion *b*, of 16 leaves, working into the slight cast-metal wheel *f*, fixed on the iron axis *ii* of the lower roller, on which axis is also fixed a small pinion *g*, of 8 leaves, working into another, *h*, of equal number, fixed on the axis of the upper roller, which gives the two rollers an equable motion for taking in the corn. This axis is fixed into the upper roller, either by an universal joint, or with a square tapering end, to allow the upper roller to rise and fall, according as the corn is fed in thicker or thinner; and the concave board RE is hung on a bolt, to allow it to rise and fall with the roller.

When the rollers are required to move swifter or slower, they may be driven very conveniently from the end of the axle to the rake, by fixing a cast metal *faced wheel* on it, with three rows of cogs, (8, 10, and 13), working into a shifting pinion of 8 leaves, fixed on an iron axle; at the other end of which is put a small *bevel* wheel of twelve teeth, working into another of eight teeth on the end of the axle of the lower roller. The fanners are moved by a crossed rope passing over a pulley T, 10 inches diameter, fixed on the axis of the cylinder, and another V, of 8 inches diameter, on the axis of the fanners. The rollers take in nearly 300 inches of corn per minute, with a medium quantity of water; *w x* and *y* explain separately the manner in which the small wheels are attached.

This machine was found to answer well at Chilling by Mr. Baily.

Some of these kinds of mills have rollers or small mill-stones added to them, for the purpose of crushing and grinding grain for horses, swine, and other animals; and also instruments for cutting straw into chaff.

Plans for thrashing-machines to be wrought by different powers may be seen in Gray's Experienced Mill-wright.

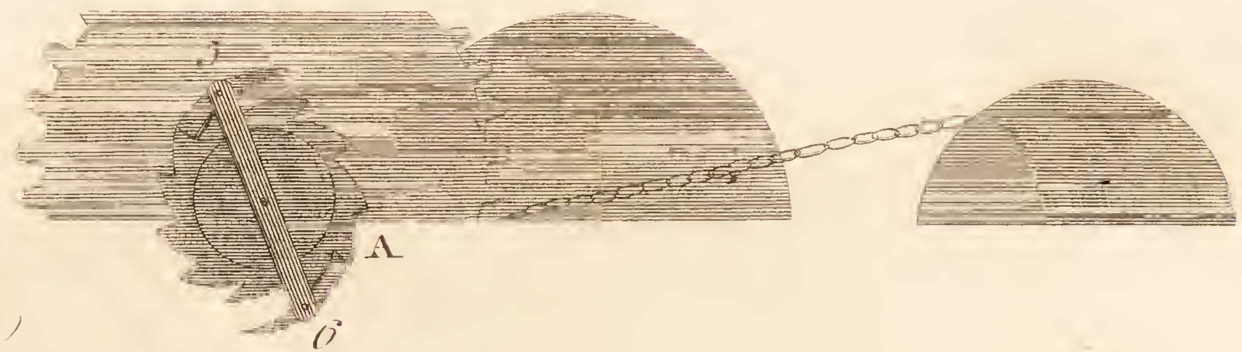
Two great improvements have been introduced into these sorts of machines, according to Mr. Young, by two young mill-wrights from Somersetshire, which were had recourse to in fixing up Mr. Newman Harding's at Hornchurch, in Essex. The first is a amovement by which the person who feeds the machine by putting his foot on a pedal, can lift one of the fluted cylinders out of it work, so that the wheat having advanced far enough to be thrashed, the straw may be drawn back again, and be preserved from being broken. This is shown in plate XL. The dimensions are from:

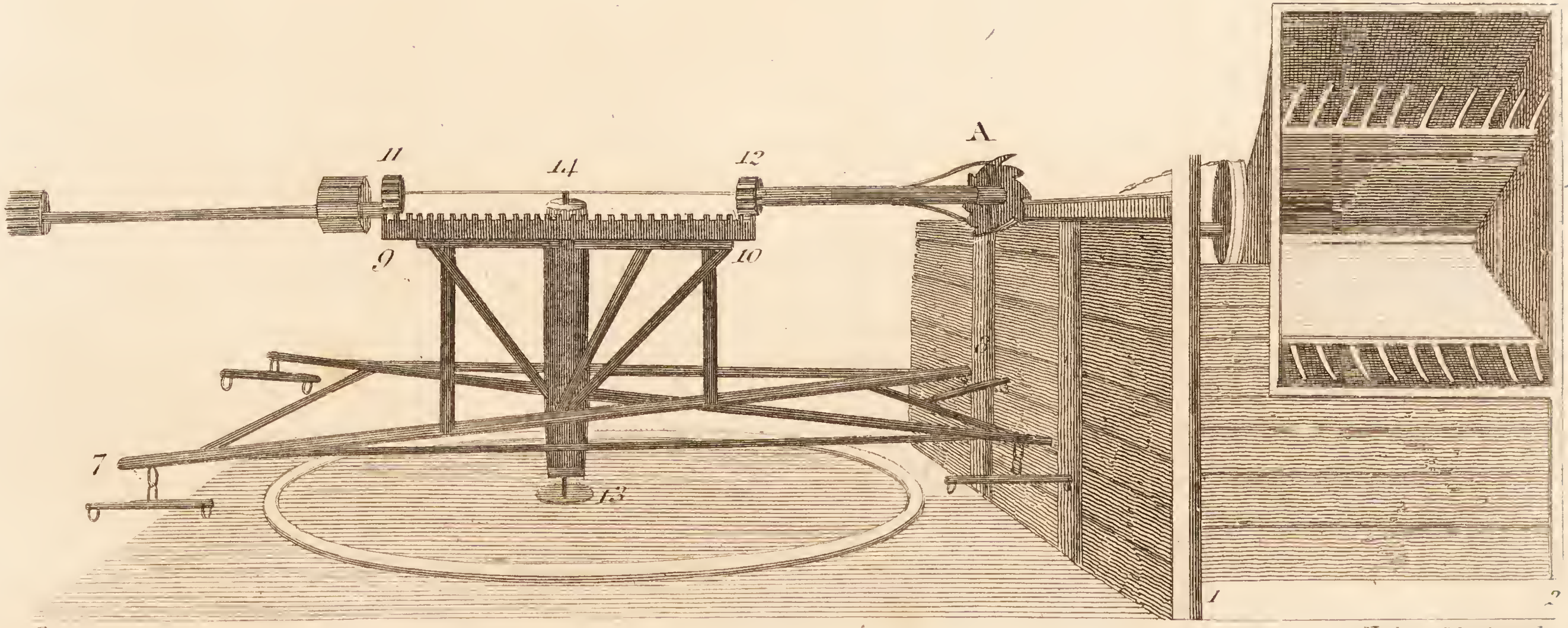
(Mr. Newman Harding's Pedal for not breaking the Straw.)

Plate XL. P. 54

Neele sculp. Strand.

(Catch Wheel.)
of the
(Thrashing Mill.)





Neele sc. 352 Strand.

		Ft.	In.
From 1 to 2	-	9	0
1	3	16	0
1	7	5	6
7	4	8	0
5	6	5	0
10	11	1	6
11	12	3	6

	Ft.	In.	
A -	2	9	diam. 45 teeth
B -	0	8	diam. 11 teeth
Drum	3	6 long	
	2	6 diam.	

Step for the foot to bear on, which divides the iron rollers, and enables the labourer to draw back the straw.

The latter is a check or iron which permits the horses to be stopped suddenly, without stopping the beaters: the connectors being momentarily removed, one acts without the other. This, with the catch or click, is shown in plate XLI. The dimensions are:

		Ft.	In.
From 1 to 2		5	0
3	4	24	0
5	6	1	1
7	8	18	0

		Ft.	In.	
From 9 to 10		10	0	Diameter.
13	14	7	0	
11	10	0	10	

A *the click.*

On the necessity of employing machines of this kind, it is remarked by an able writer, that it is the only method left for having the corn cleanly and properly thrashed. They are so quick in the work that the whole may be done under the eye of the master, and the corn secured in the granary without the least pilfering. The saving by this means of thrashing, in the extra quantity of corn procured, and the security against having the corn stolen in the chaff, it is asserted, amounts to an advantage in favour of the mills of about ten per cent. on the corn crops; in some cases, to one shilling a bushel on wheat, and very generally to twenty shillings an acre on wheat crops.

This machine has undoubtedly many advantages over the flail, as well as those of saving time and hands; as in thrashing damp corn, not capable of being fully accomplished in any other way, especially in wet seasons; and with smutty wheat, which is thrashed by it without any mischief being done to the sound grain, the smut not being crushed comes out whole, and is blown away with the chaff. And in addition to these, it has the great advantage of preventing the necessity of large barns.

The principal objections that have been made to these machines are: the great expense of erecting and using them, their tendency to diminish the labour of the poor, and their affording too great a supply of straw at a time. These objections are, however, of little consequence, when the general utility and advantages of such machines are considered: besides, the latter are either such as have nothing to be apprehended from them, or as may be readily obviated. The difficulty in regard to the straw may be easily removed, by having it properly stacked up, or cut into chaff.

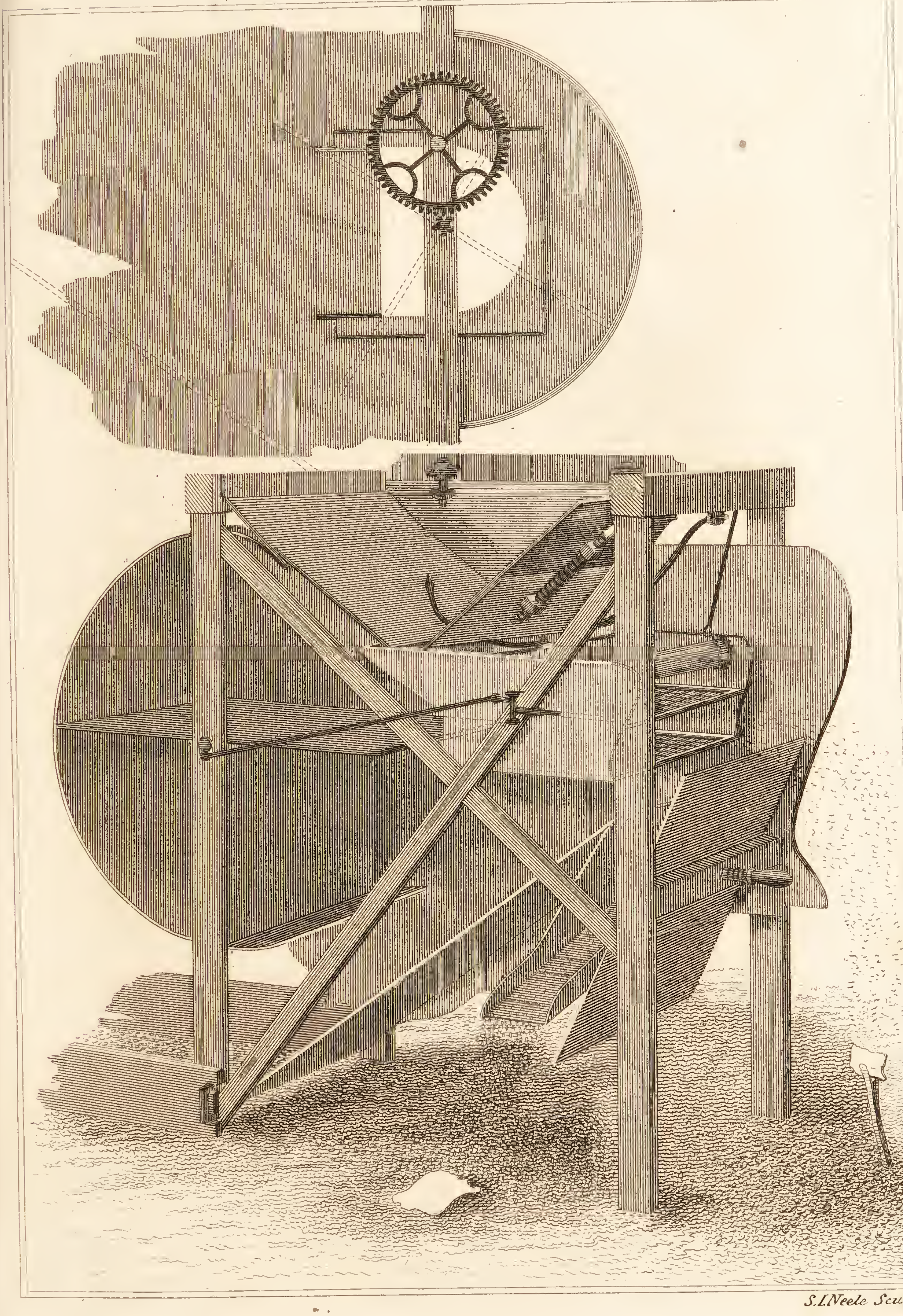
Winnowing-Machines.—Machines of this sort are in pretty general use where thrashing-mills, to which they may be attached, are not erected: they are made on different principles, according to particular circumstances. Those contrived by Mr. Cort of Leicester, on Mr. Winlow's plan, are good implements, and will dress grain with much dispatch. And there are others which are employed in the northern districts, which are made by Rodgers, that are also upon good and convenient principles: as well as many more in different places, which have great merit in their construction, and do their work well and expeditiously. They are made of different prices, from three to five or six pounds, and will last many years when the materials of which they are formed are of a proper kind. A machine of this kind, made by the late Mr. M'Dougall, is seen in plate XLII.

Chaff-Cutters.—Of these useful implements there are a great variety, formed on very different principles. There seems, however, in general to have been too little attention paid to their construction, as there is scarcely one so cheap as to be suited for general use. Those made on Mr. Cook's and Mr. Nailor's plans are in much esteem in many places; but one lately constructed by the successors of Mr. Winslow, and other manufacturers in London, in which the straw is regularly brought forward by an iron cylinder contrived for the purpose, as the implement is turned round, and cut by means of two or three knives fixed on the wheel, would seem to be more convenient. It has been suggested, however, that a wheel with two knives fixed on its radii will cut more straw in a given time, and with a given force, than a wheel with three knives, as, where there are three knives, one of them is always upon the straw; the resistance is, of course, so great and constant, as materially to diminish both velocity and momentum, and consequently power. Mr. Burrel, of Thetford in Norfolk, we believe, has attached to the side of these machines a crank, which, by means of a spindle terminating in a cog-wheel, much assists the primary force. Two boys, or women, are capable of turning this wheel for many hours together. It is probable that the application of a multiplying wheel to these machines would much facilitate the labour of them. Straw, may, however, be well and expeditiously cut by almost any of these implements; but in many districts, from their great expense, the common cutting-box is still in use.

As the principal objects aimed at in this sort of machine are those of expedition and the lessening of labour, it is obvious that many of the improved instruments of this kind must answer these purposes much more effectually than those that were formerly in use, especially where they are attached to any great power, such as that of horses or water, as in the case of thrashing-machines, or other mills for which they are in common adapted.

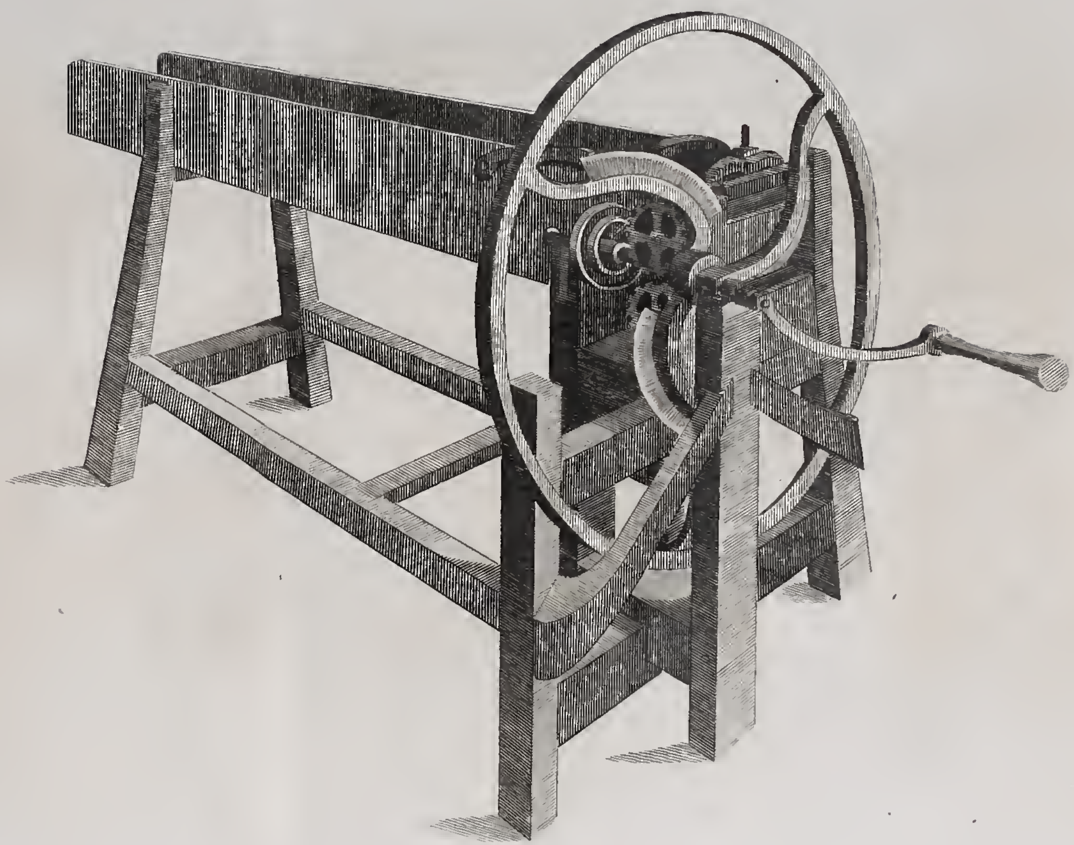
In plate XLIII. is given a representation of Mr. M'Dougall's patent chaff cutter, which is one of the most useful instruments of this kind. In this machine the inventor has been particularly careful to construct it in such a manner as that, in case it be accidentally broken, it may be easily repaired by any common mechanic. The substance

McDougall's Winnowing Machine.



S. I. Neele Sculp.

CHAFF CUTTER.



BRUISING MACHINE FOR CORN

Fig. 3.

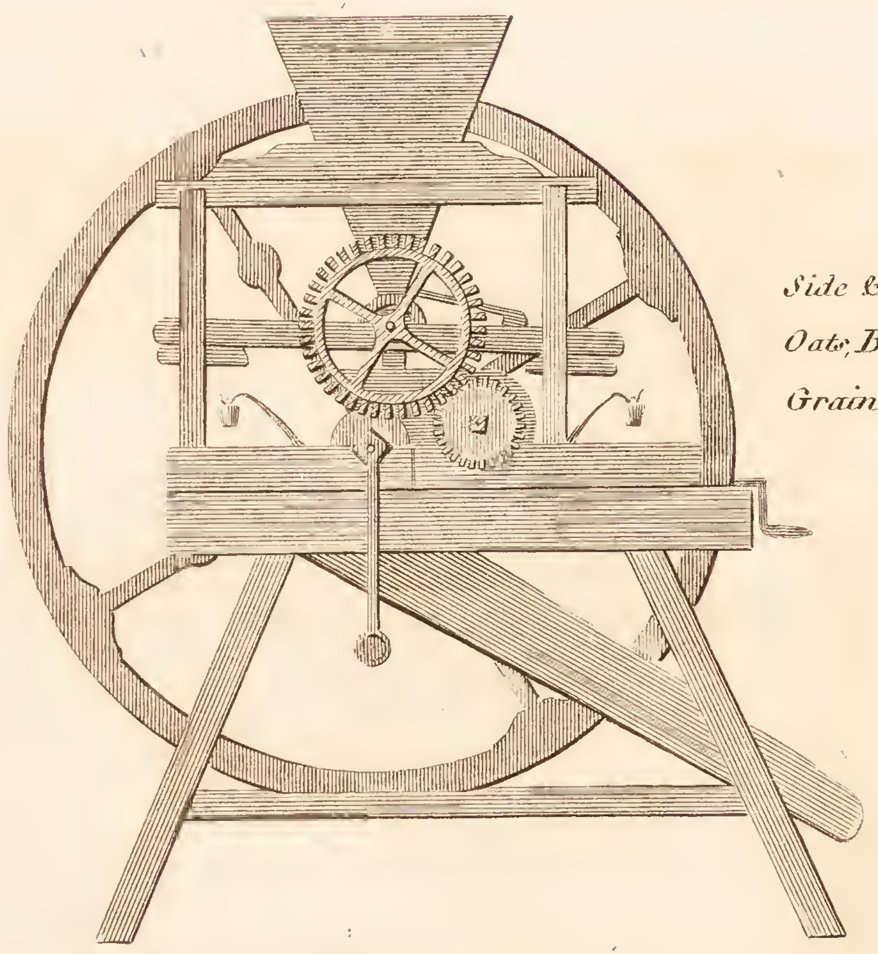
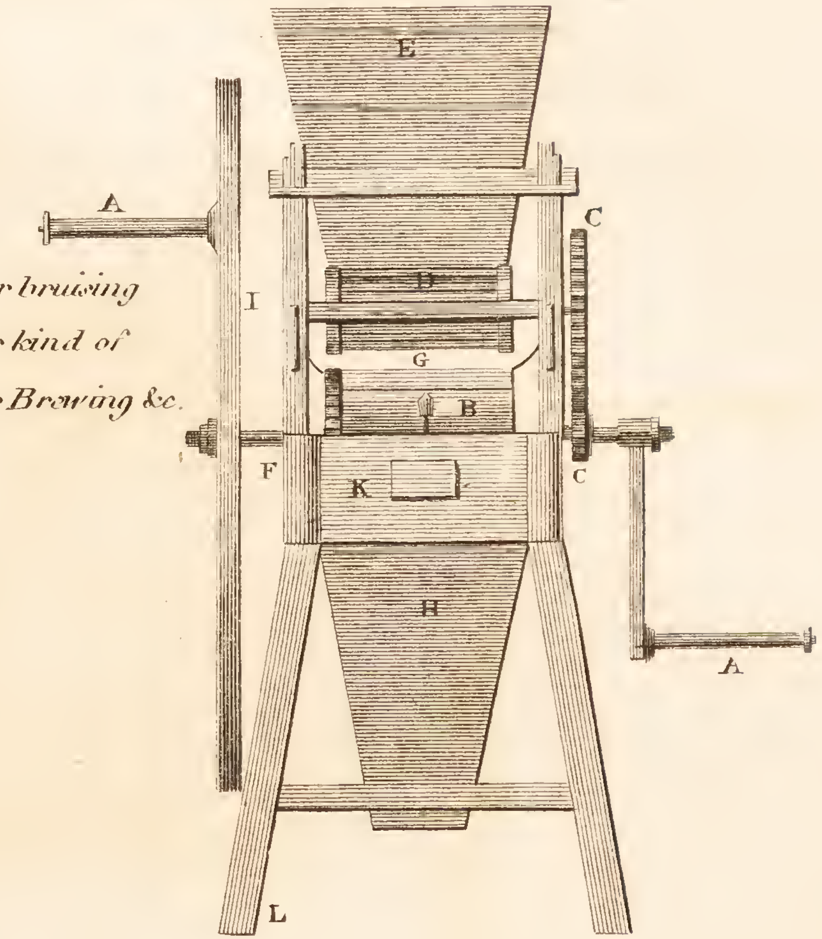


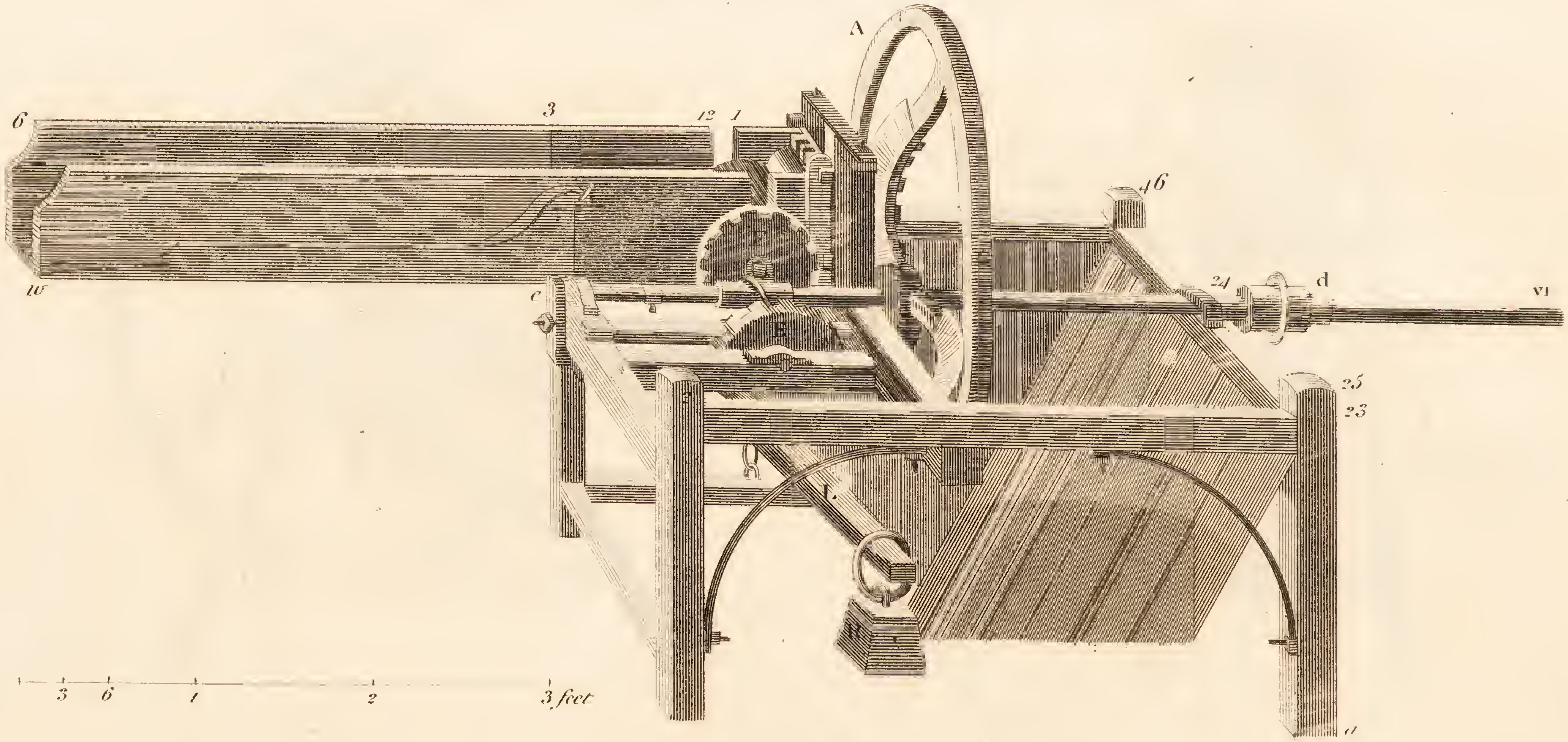
Fig. 4.



Side & End View of a Machine for bruising Oats, Beans, Peas, Barley or other kind of Grain for feeding Cattle, Malt for Brewing &c.

Printed for Richard Phillips, *Bridge Street London.*

A Chaff cutting Machine worked by a Horse, at E. L. Lovedens Esq.



Neele sc.

to be cut into chaff may be pressed as the workman chooses, by simply placing a weight nearer to the end of the lever. But the chief excellence of the implement consists in its having a spiral groove in the room of the endless screw commonly used; by means of which, friction is in a great degree got rid of, and the lever is capable of rising to any height without putting the machine out of work. A great number of machines of this nature have been lately invented which perform their work well. A large powerful machine of this kind employed at E. L. Loveden, Esquire's, in Berkshire, is shown in plate XLIV. It cost sixty guineas, and is worked by one horse, cutting sixty bushels of chaff in an hour, in the most perfect manner.

Bruising-Machine.—Though the utility of having grain reduced by machinery, before it is employed in the feeding of horses or other animals, has been disputed by some, on the supposition of its not being so intimately combined with the saliva of the animals, on account of less chewing being required, there can hardly be any doubt but that it will go considerably further when partially broken by such means, as experience has demonstrated its œconomy and advantages in many instances, in the keeping of a great number of horses for the purpose of a colliery by Lord Dundonald in Scotland. His lordship forcibly observes "that all corn given to horses or other cattle should be broken, by being passed through rollers or crushed in a mill." For "horses, not being ruminating animals, will receive considerable benefit by this œconomical operation, and the loss or waste by swallowing their corn whole will be prevented."

At fig. 45. in plate , is a side view of Mr. Rowntree's machine for bruising different sorts of grain, as well as pease, beans, &c., for the purpose of feeding horse or other sorts of teams. It is likewise capable of application in the grinding of malt for brewing. And at fig. 2. is an end view of the same machine. This machine is constructed with two iron rollers of different diameters, turned true on their axles or spindles, each roller having a cog or tooth-wheel. A roller with grooves is fixed under the hopper, to receive the grain from the hopper and lay it on the two rollers. To one of the rollers is fixed a fly wheel. The machine is made to be worked by hand or any other power. The upper wood frame is made to slide, and is regulated by a screw according to the size of the grain, and will bruise it more or less as may be required.

AA the handles.

BB the rollers for bruising the grain.

CC the cog or tooth-wheels for turning the rollers.

D the fluted roller which receives the grain from the hopper E.

F the sliding frame.

G the screw for regulating the rollers.

H the shoot or trough for conveying away the grain from the rollers.

I the fly wheel for regulating the motion.

K two scrapers hanging on centres for keeping the rollers clean.

L the frame.

Rakes.—Implements of this kind are employed for different purposes in practical husbandry.

The common *hay-rake* is too well known to require any description; but a late improvement upon it seems to deserve notice. This is the making of the teeth to screw into the heads, and fasten with screw nuts, by which the danger and inconvenience of their dropping out is prevented.

With these *spring-teeth rakes* one person is said to do considerably more work than with the common wood-rakes; and they are made use of both for hay and corn with great ease and convenience. Rakes are constructed in this way, and sold by Mr. Cort of Leicester.

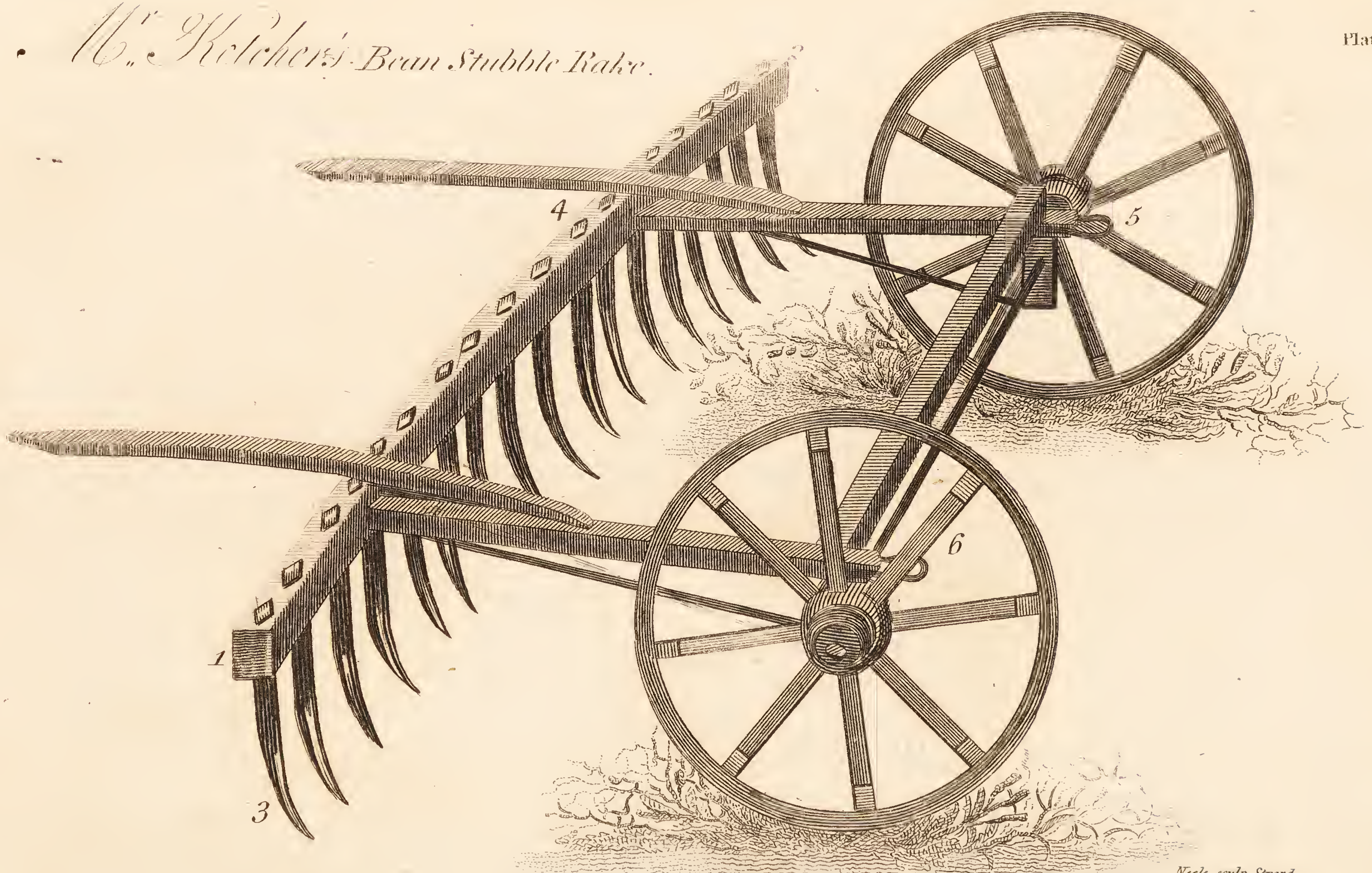
The *corn-rake* is a large rake made use of in many districts for raking together the grain after it has been mown. It is sometimes made with wooden teeth, seven or eight inches in length; but as these are very apt to break, it is a much better method to have them of iron, in which case they should be a little bent forward. As it requires great exertion in using these rakes, they should be constructed in as light a manner as is consistent with the work they have to perform.

The *twitch-rake* is a sort of rake which is frequently necessary for the clearing of certain descriptions of land from these as well as other kinds of weeds. The best way of making it is probably with a double row of teeth, those of one row being placed opposite the intervals of those of the other. By this means it is rendered a more convenient and effectual implement.

An effective *couch-grass rake* has been invented and delineated in Mr. Amos's "Minutes of Agriculture and Planting." He observes that this sort of grass is one of the worst of weeds among corn, and one of the most difficult to extirpate in arable land, as every joint of the root throws out a number of stems. The usual method of destroying it is, he says," by fallowing the land, harrowing and rolling it well, and then gathering the couch-grass by hand into heaps and burning it; which is not only very tedious, but expensive. But by the use of this machine and the couch-grass drag the labour and expense," he asserts, "is very much reduced. Between the second and third ploughings is the most proper time to begin the operations of cleaning the land of couch-grass." He remarks that "the first thing to be done is, to make the land fine by rolling and harrowing, then to leave the land under the impression of the roller, in order to level the surface, and to press down the clods out of the way of the rake: and the next is to rake the land the cross way of the ridges: when the rake has gathered as much of the couch-grass as it can hold without losing any of it, the man must lift up the handles so high as to permit the couch-grass to fall off from the rake teeth; the horse then going forward, he drops the rake just beyond the row thus gathered together. This he repeats as often as the rake is full, till he reaches the side of the field; he then turns, and, coming back by the side of the part raked, empties the rake adjoining to the first row. By this means the couch-grass lies in straight rows the lengthways of the lands. When the field is finished this way, or before, the rows must be collected into heaps, forked over to lighten the couch grass, and burnt."

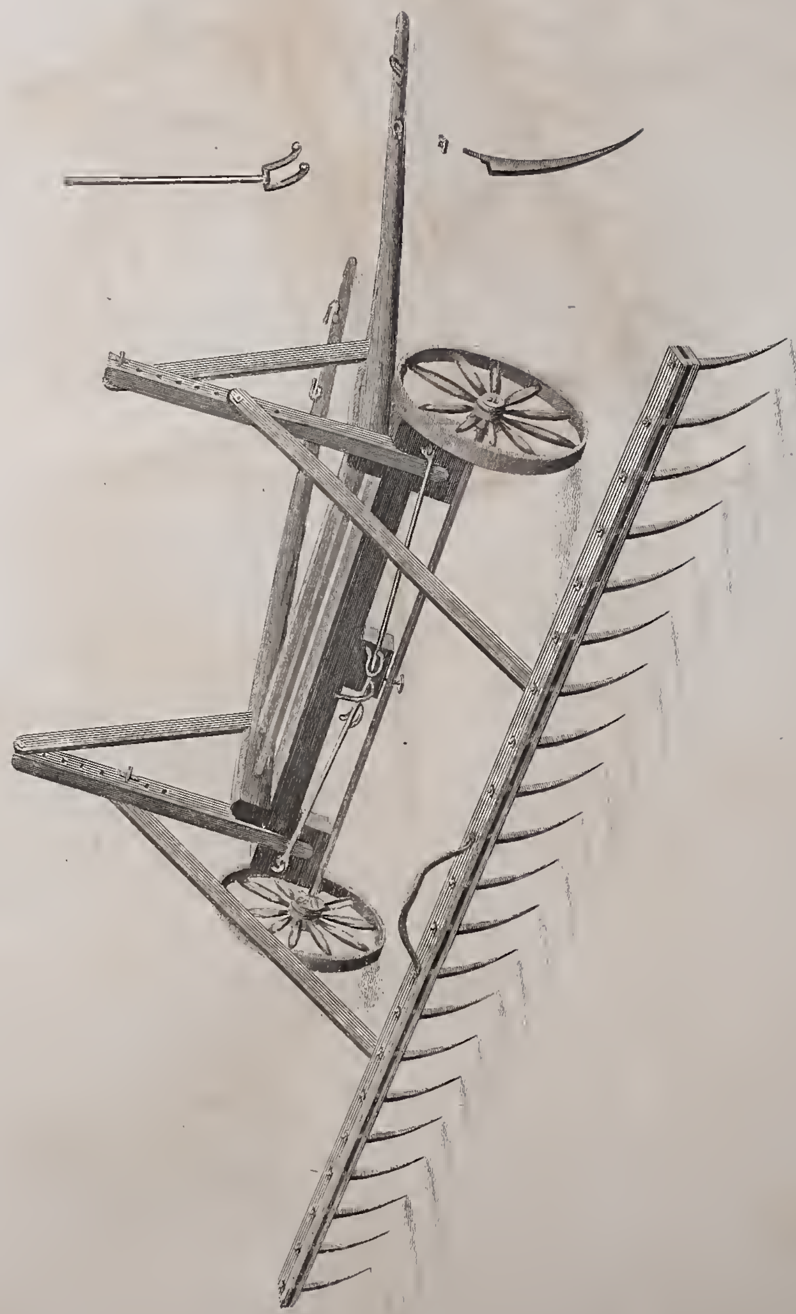
Mr. Ketcher's Bean Stubble Rake.

Plate XLVII.
Page 59



Neele sculp. Strand.

NORFOLK & SUFFOLK HORSE RAKE.



The *horse stubble-rake* is a large heavy kind of rake, with strong iron teeth, fourteen or fifteen inches in length, placed at five or six inches distance from each other, having a beam about four inches square, and eight or ten feet in length. It it commonly drawn by two horses, and is very effective in clearing stubbles. In plate XLVI. is given the representation of the *Norfolk* and *Suffolk horse-rake*; which is an useful implement, much employed on the large and middling-sized farms in those districts, and extending itself into others. It is made use of for barley and oats in the place of the hand-drag or *dew-rake*, so named from being chiefly employed while the dew is upon the ground, before some other sort of harvest work can be undertaken. A man and horse driven by a line are capable of clearing from twenty to thirty acres in a moderate day's work, disposing the grain in lines across the field by lifting up the rake and dropping it from the teeth without the horse stopping. It is recommended by Mr. Young, and the price is from four to five pounds. And in plate XLVII. is a *Bean-Stubble-Rake*, which is employed by Mr. Kitcher in Essex, with great success. The dimensions are:

				Ft.	*In.*			*Diam.*	*Wheels*
From	1	to 2	-	7	8			2	6
	1	3		1	6	5	6	4	0
	4	5		3	2			*Hooks for Horse.*	

Wheel Carriages for Husbandry.—The *waggons* which are employed in husbandry are constructed in different forms and of various dimensions in different districts, and, in general, without sufficient attention to the nature of the roads or the materials that are to be carried. They are indeed commonly much too heavy and clumsy to be convenient. The Berkshire waggon would seem, however, to be constructed on a more neat and convenient principle than those which are made use of in most of the more southern counties: it is neither so heavy nor so high, while it possesses sufficient strength, and is easy in the draught.

A very useful improvement in this carriage has been suggested in a late publication, which is that of leaving the space sufficiently deep in the bed of the waggon for the fore wheels to lock round in the shortest curve, as, by the present mode of construction, much time is lost in turning at the ends of swaths in carrying hay, and on many other occasions. In this way the inconvenience may be removed without doing the smallest injury to the symmetry or strength of the carriage. But those employed in Gloucestershire are preferred to any others in the kingdom by an intelligent writer, who has attended much to the subject; as by means of a crooked side-rail, bending archwise over the hind wheel, the bodies or frames of them are kept low, without the diameter of the wheels being much lessened. The bodies are likewise made wide in proportion to their shallowness, and the wheels run six inches wider than those of most other waggons, whereby advantages in carrying top-loads are evidently obtained.

In many districts, waggons are the principal carriages employed in getting in the hay and corn and carrying them to the market, and

likewise in bringing manure, coals, and various other materials. In such cases they are generally drawn by the whole team on the farm, and two men, or a man and a boy, are necessary to attend them in performing the business.

But this sort of conveyance, however well constructed, from its great weight and unwieldiness, as well as its expense, seems far from being advantageous to the interests of the farmers; as, while it is highly destructive of the roads, it requires great power in the draught, which must be procured at much expense, without affording an adequate compensation in the quantity of materials which it conveys. It is however supposed by a later author, that in performing distant carriages, where the roads are level and substantially made, and the waggons at all times *fully loaded*, one of them may probably be as advantageously used as two or more carts of less dimensions; but that where the labour is required to be performed with expedition, as in the harvesting of hay and corn, such unwieldy machines are ill calculated for the purpose; and that on every occasion, where they return only half or a third part loaded, the farmer must obviously sustain a considerable loss.

The common waggon employed in the collieries for conveying coals is perfectly well known.

The *light waggon* which is much used in Berkshire, and which is valuable, from its lightness, for harvest and other similar purposes, is common now in many places. And another waggon, which partakes, in some degree, of the properties of the cart and waggon; whence it has been appropriately denominated *hermaphrodite*. The pair of fore-wheels and shafts are occasionally attached to a common cart, by a pole connected with the axle, to which are added the ladders. This is a light, cheap, and convenient carriage, and will carry nearly as much hay or straw as the above waggon.

In plate XLVIII. is shown the *Woodstock waggon*, in the state in which it is mostly used. And plate XLIX. displays the several different parts of it. The dimensions of which stands thus.

Fig. 1.

	Ft.	*In.*		*Ft*	*In.*
79 69,	12	14	1 g,	0	11
12 9,	12	4	9 j,	4	4
79 12,	1	0	R 22,	1	10
69 9,	0	0	R 14,	1	2
9 15,	1	3	K B,	1	0
15 L,	5	3	x N,	0	11
L X,	5	9	N K,	0	4
X 4,	4	3	M N,	4	1
4 N,	5	9	L M,	0	4
e x,	6	0	L K,	3	5
e d,	11	4	h d,	3	8
e i,	0	10	G F,	2	0
i o,	0	6			

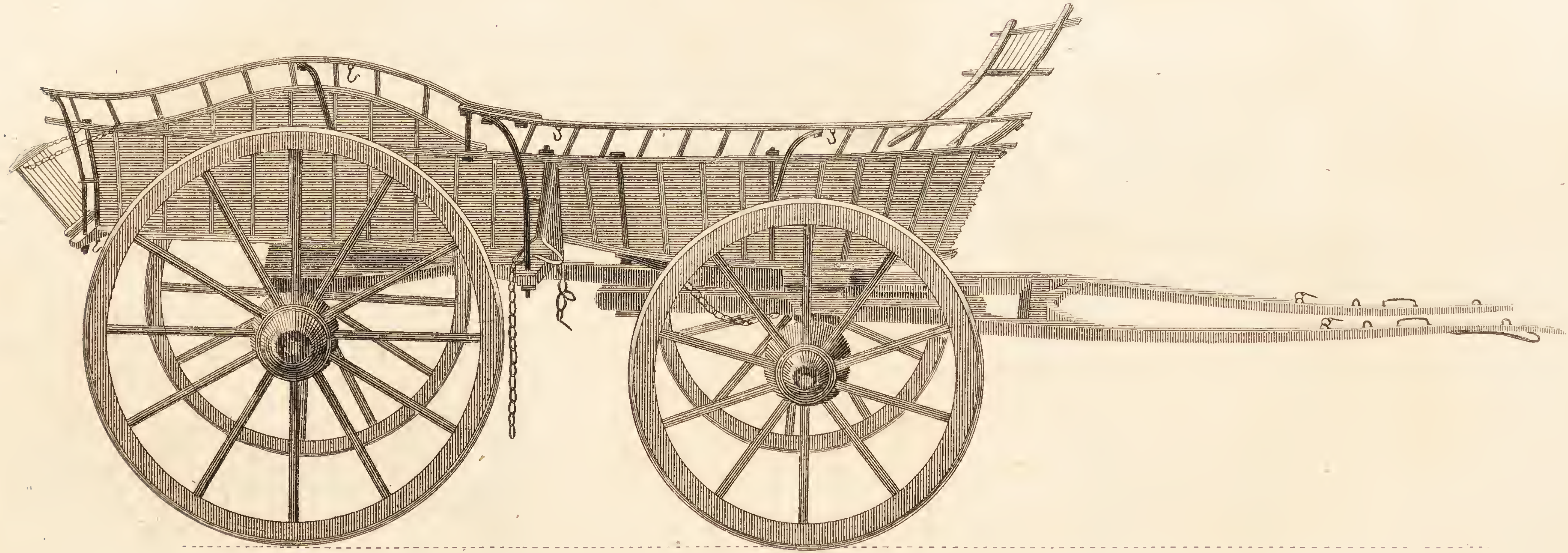
Fig. 2.

	Ft.	*In.*
a b,	12	4
D 7 2	6	0
1 D,	0	10
e o,	5	4
i i,	4	4
x 4,	4	3
15 40	3	4
L K,	3	5
x L,	5	9
x 15,	1	0
x E,	4	0
E t,	5	4
62 79,	5	8

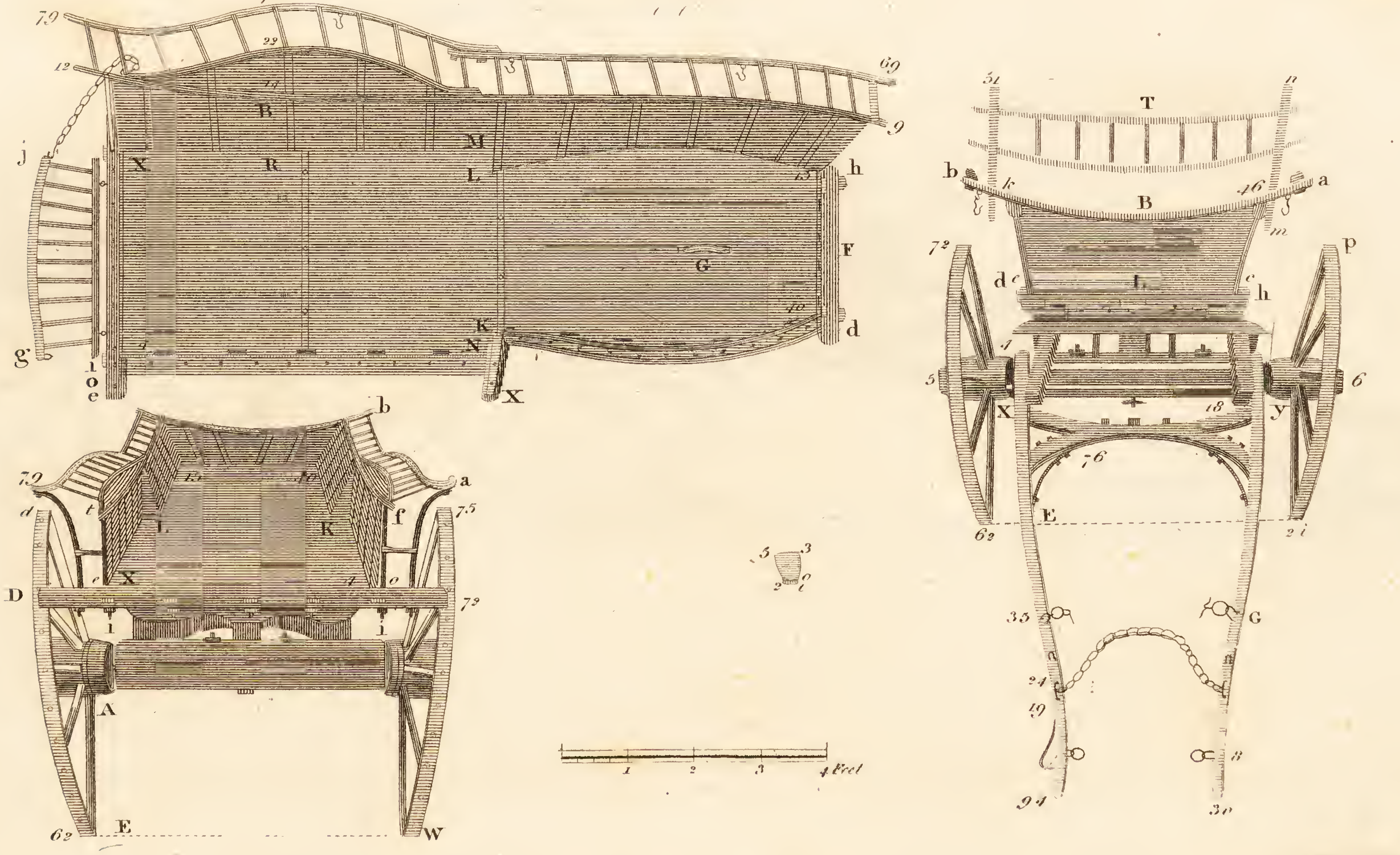
And in plate L. are given the elevation and plan of the bed of the *Sussex waggon*; which is found very convenient and useful.

PL. XLVIII. Page 60

The Woodstock Waggon.

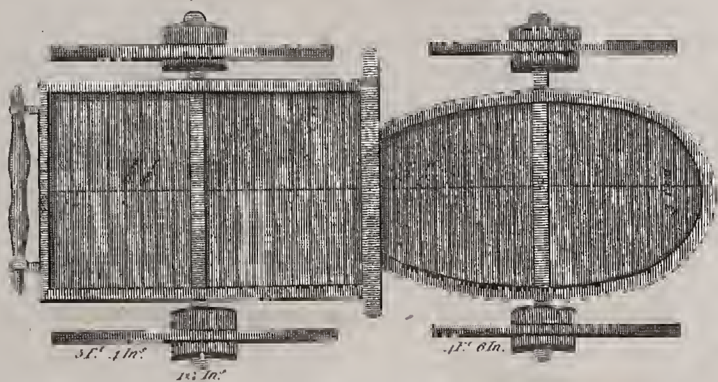


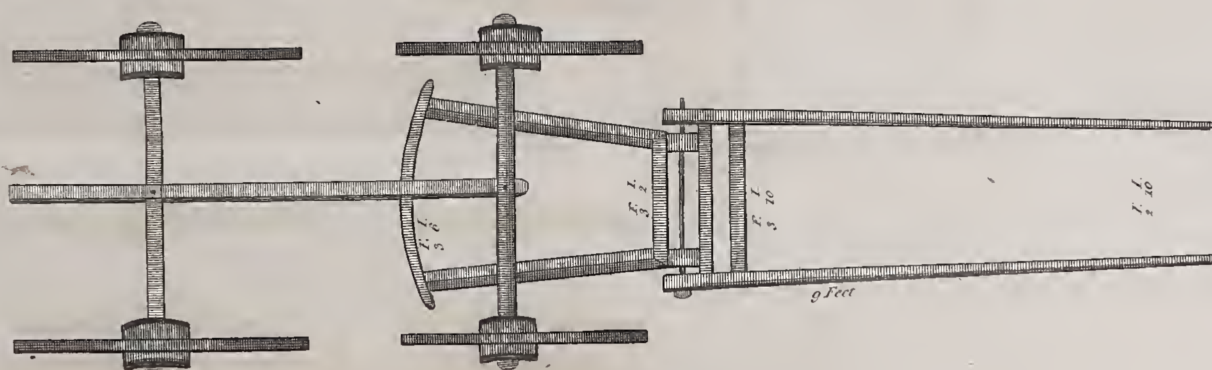
Parts of the Woodstock Waggon



Neele sc. Strand.

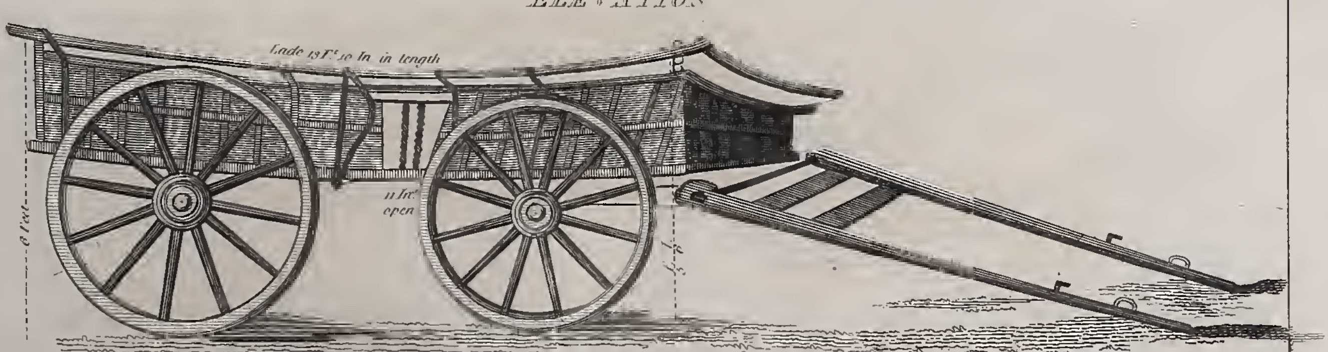
Plan of the Bottom of the Waggon.





Plan of the Frame or Timbers under the bottom of the Waggon.

ELEVATION



Neele sculp.t Strand.

The use of heavy carriages being found inconvenient in performing some sorts of business, farmers, in particular instances, have had recourse to a lighter sort of vehicle for conveying manures and other materials of the same kind upon land, while large waggons are employed for other purposes. In this way the improved *Irish car* has been made use of, and found well adapted to the conveyance of such substances; a good horse being capable of drawing with ease and expedition more than a ton weight.

In its construction it approaches much to the square form, being only a few inches longer in the bed than it is broad; the wheels are made low and broad, with a flat bearing, and placed under the body of the machine. From these different circumstances it possesses many advantages; it can be readily filled, pass confined gateways with facility, and be drawn upon soft meadow or ploughed grounds with much less injury and inconvenience. From the cylindrical form of the rims of the wheels, much less resistance is said to be given in the draught; consequently heavier weights can be drawn. The business of husbandry in Ireland is chiefly performed by this sort of small carts, where hay, or corn in the straw, is to be carried, ladders being added. They are, however, thought inferior to the single-horse cart by some persons who have closely attended to them.

Carts.—The *carts* used in agriculture are made with much variety in different districts, but, like waggons, are probably, in general, too heavy in their construction to be employed with the greatest advantage. In some places they are so formed as to be, when empty, full as heavy as one horse can draw, especially where the wheels are broad, and of course much resistance occasioned by the increased friction. Nothing can, indeed, be more injudicious than the enormous bulk and clumsiness of the farm-carts commonly employed in some districts; and the inconvenience and loss that result from the use of such clumsy carriages are greater than can be easily imagined. Besides, in consequence of the great height of the wheels, the nave, spokes, and fellies must all be made of such weighty materials, in order to render them moderately strong and firm, as not only to add a prodigious unnecessary load to the horses, but greatly to enhance the expense of such vehicles. The difficulty of loading the cart, too, is so much increased from the same cause, as at least to double the expense that it might be performed at. And, on account of the number of horses that are required to draw them, and the time lost by the men in filling them, as well as the damage done upon retentive subsoils by their being torn into deep ruts, they are clearly shown to be less advantageous than those of the smaller kind. Lightness in a carriage that is to go upon land is a quality of the first importance in the business of a farm: this is particularly evident when it is considered that by such means, with the same strength of draught, more than four times the quantity of work can be done in the same length of time. Low wheels in vehicles of this sort also enable a much heavier load to be drawn; and of course render small carts preferable on that ground as well as those that have been stated. Carts, if properly constructed, for many kinds

of weighty goods, need not, independent of wheels and axle-tree, weigh more than one hundred weight, and for most purposes they need not exceed two hundred weight. Large waggons, as well as heavy-constructed carts, should, therefore, except in particular situations, be exchanged for those of the lighter kinds; by which more work may be performed in an equal length of time, and with much greater ease and convenience.

Single-horse carts.—The large wains, or heavy four-horse waggons, which are common in many of the southern counties, are not only reprobated, but in a great measure exploded, in those of the north, where one and two-horse carts, with some variety of construction, are mostly made use of. One horse with these carts draws from twelve to twenty-four hundred weight, and on good road sometimes thirty, with great facility. In the most improved cart of this sort, the bottom, when placed on the axle, projects, on each side, over the inner heads of the naves, so as nearly to touch the spokes of the wheels; from which acquisition of breadth the capacity of the cart is much increased, while the side standards, by being brought nearer to the perpendicular situation, are enabled to sustain considerably more weight. This is termed the *close* or *coup cart*, and is about five feet three inches in length, four feet in breadth below, and four feet three inches above, having a depth of one foot three inches, and containing about a cubic yard. The wheels are commonly about fifty inches in height, and the axle-tree mostly formed of iron, though wood will answer the purpose tolerably well.

A very intelligent agriculturist, who has paid much attention to the importance of carts in husbandry, found in constructing single-horse ones that the capacity of waggons was by no means a just rule for them. From those with which he was acquainted, containing in the bed, or *buck*, ninety-six cubical feet, being twelve feet long, four feet wide, and two in depth, it was supposed that to give one horse the fourth of the load of four, it would only be necessary to give them a space of twenty-four cubical feet, or to make them four feet by three, with a depth of two feet; but it was soon observed that the power of a horse was so much greater in working singly than in a team, that they might be enlarged so as to have the dimensions of five feet one inch in length of *buck*, three feet seven inches in breadth, two feet in depth, and to contain thirty-five cubical feet and a fraction. This places in a striking point of view the advantage such small carts have over large ones in the quantity of work performed.

On the subject of single-horse carts it is also observed by another practical writer, "that those which are in use in various parts of England appear to be the best calculated for the purpose of carrying all kinds of goods, (except single trees, blocks of stone, or any other article whose weight may be too much for the strength of such carts, and which cannot easily and without loss be divided into separate loads,) in all or most places where the roads are particularly bad, either arising from soft mud and clay, or large stones, and where there are deep ruts, especially in hilly countries, and where the

people are poor, and consequently particularly studious to keep their expenses under as much as possible. These are the places; and the people with whom single-horse carts are in common use; which is a strong proof of the œconomy of the plan." "It is equally certain," he observes, "that where the country is level, the roads free from ruts, and the people rich, they indulge in expensive horses, and in teams of parade and show; "such, for instance, as those used by the brewers and distillers of Middlesex and Surrey." It is also further stated, that he has four of these one-horse carts in use himself; and that in loading the gravel of flints they are always filled to carry twenty-five cubical feet, and for manure from thirty to forty. The great superiority of these carts is rendered still more obvious and striking by the observations that "two horses, yoked in single-horse carts, will draw as much as three horses yoked in one cart; that a common carrier at Carlisle, who many years employed a waggon, had laid it aside, and now uses single-horse carts only; as he finds he can by that means carry much greater weights."

It is likewise supposed in the same work, that the superior goodness of the roads in Cumberland may be ascribed to the general use of single-horse carts; and that wherever waggons are employed they are the destruction of roads, especially where the country is hilly, and where they are under the necessity of having the wheels locked, as in such cases the banks are in a manner ploughed up by them. The same objections are equally strong against large and heavy carts, as they produce the same bad effects, only in a somewhat less degree.

It is, in short, strongly contended, that waggons cannot be advantageous to the farmer, since the same number of horses yoked in single-horse carts will draw considerably more than when yoked six or eight together. Besides, it is conceived that single-horse carts are superior on other grounds; they are loaded and unloaded with greater ease and convenience, and are more handy for almost every purpose, and six or eight of them may be managed by a man and a boy at very little expense.

In these carts, too, the size of the wheels can be adapted with the greatest exactness to the height of the horses, and be placed with more convenience in regard to the centre of gravity of the load, by which the draught is considerably lessened.

In fact, the Cumberland farmers, and those of some other counties, are fully convinced that very great advantages are derived from using carts of the single horse kind. This sort of cart has likewise been compared in many different points of view by an accurate observer, and found in almost every instance to be greatly superior to waggons, or tumbrils, for almost all the various purposes of the farm.

Where small carts are employed, it is frequently the custom to have different sorts for different purposes; those of the close kind being principally employed in carrying out dung, compost, and such-like compact heavy materials; while others made of a kind of frame-

* The mountainous districts of Derbyshire, Wales, Cumberland, Dumfries, Dumbarton, &c. &c.

work are occasionally placed on the same wheels, and used for conveying bulky loads, such as corn in the straw, hay, and other similar substances, and which are in consequence denominated *corn* and *hay-carts*. But the small cart, which is termed *farmer's cart*, as well as most of the small-sized carts, and all those of the larger kinds, by having ladders attached to them at the ends and sides, may be conveniently employed for all the purposes of the farmer, without the trouble, inconvenience, and expense, of such a number of different sorts of carts.

A very convenient and useful form of cart for almost all farming purposes, especially in hilly districts, is in use in some parts of Wales, as about Llandillo; it is commonly drawn by three horses, one in the shafts, and two abreast before. The wheels are so made and placed, that the weight principally lies on the perpendicular spoke; the body of the carriage is short and rather broad, but made with such a curve as to give the load an inclination towards the axle-tree. This cart serves different uses; the body conveying dung, coals, &c. while by the addition of shelvings, in the way just noticed, the different crops can be carried with great facility.

When carts are intended for the quarry, and consequently carrying very heavy weights of solid materials, such as broad flat stones, slates, &c., they should be made low and without ledges, in order that they may be loaded and unloaded with care and convenience, and be sufficiently strong to prevent their giving way under the pressure of such loads.

Some ingenious improvements have lately been introduced in carts by Lord Somerville, in order to prevent the too great rapidity of their motion in going down steep hills, and for adjusting the positions of the centre of gravity of the load, so as to have a suitable bearing on the horse, or other animal, which draws them in such cases. The first has been effected by means of friction on the sides of the wheel, by the application of what is termed a *friction-drag*, instead of the usual inconvenient and dangerous method of locking the wheels; and the latter by a kind of toothed rack fastened to the front of the cart by a screw, and worked by a pinion and handle fixed to the pole, where the cart is made to be drawn in that way; and so contrived as to admit of the fore part of the cart being elevated in proportion to the steepness of the declivity; by which means the weight of the load is thrown more upon the axis, and consequently relieves the necks of the cattle which are employed in the draught. Another more simple method of accomplishing this point is by a strong piece of iron, which is bent so as to form part of the arch of a circle, the radius of which is nearly equal to its distance from the axis of the cart, and which is perforated with holes, for the admission of a strong iron pin, by which the body of the cart is kept at any desired inclination with the pole.

The friction bar, or drag, by being connected with the tail of the cart by a small chain, and to the front by a closely notched or toothed rack that catches on a strong staple, can be made to afford different degrees of pressure on the sides of the wheel, according to the nature of the hill, or the inclination of the driver. From the

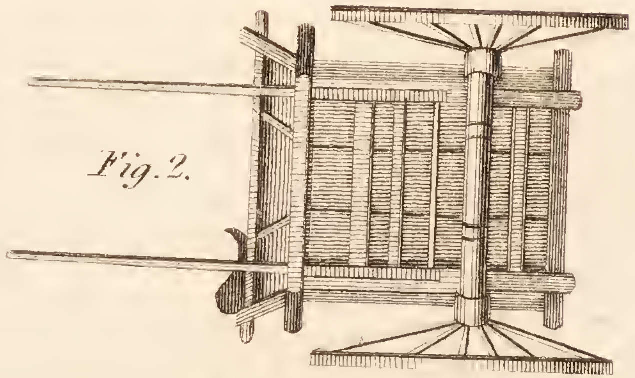


Fig. 2.

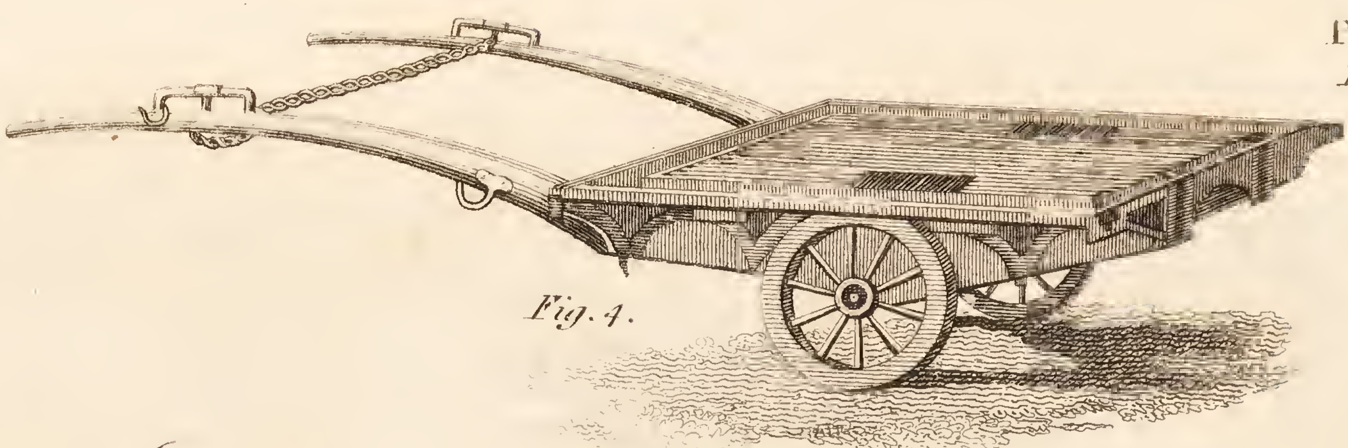


Fig. 4.

Carts.

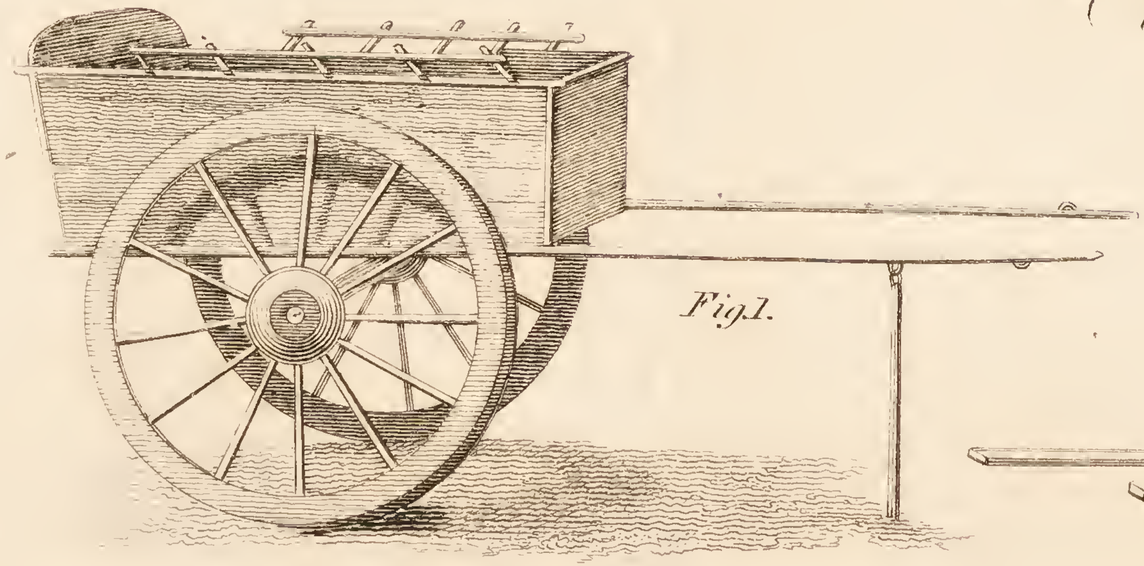


Fig. 1.

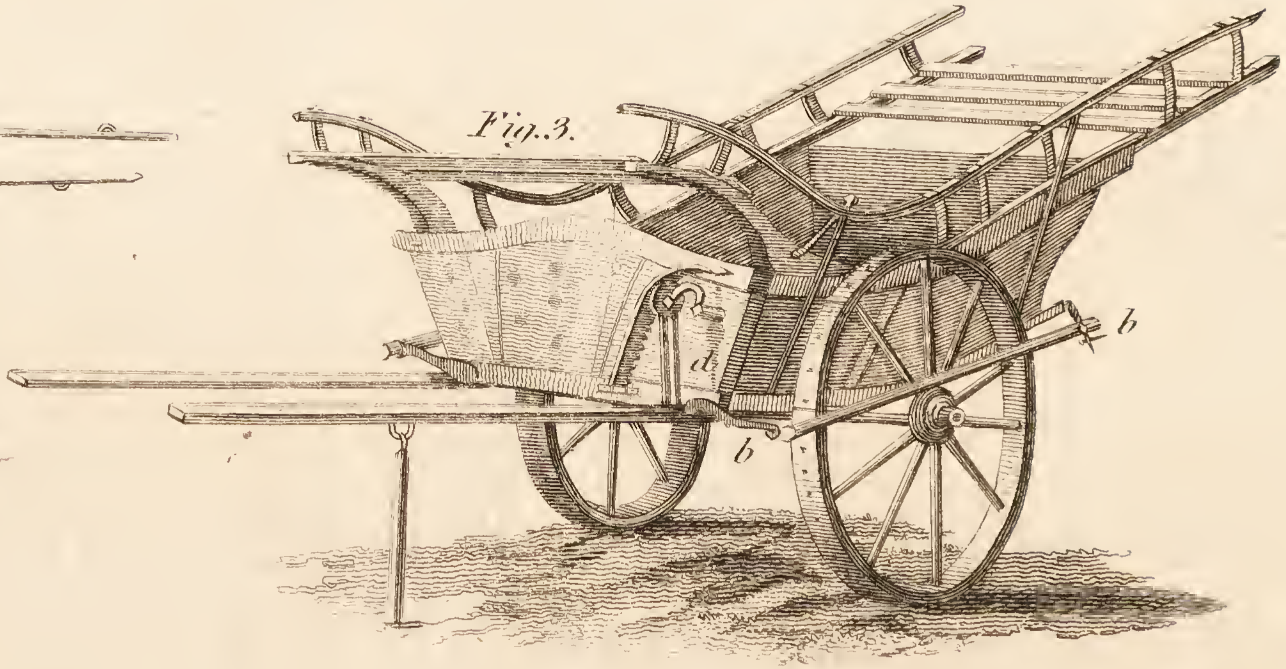


Fig. 3.

circumstance of this application of the drag, it has been termed a *drag-cart*.

By these ingenious and simple contrivances many advantages are produced, the danger to which horses and drivers are frequently exposed is obviated, much time saved, and the destruction of the roads considerably lessened.

As it has been shown that those parts of the neck and shoulder-blades on which the collars rest in draught-horses have that degree of slope, or inclination, which forms an angle with the horizon of about fourteen or fifteen degrees, it is plain that the line in which they draw should form the same angle; as in that case they will pull in that line of direction which coincides the most with the shape of their shoulders, and, of course, all the different parts of their shoulders will be equally pressed or acted upon by the collars. Hence horses draw more, in conformity to their mechanism, in a sloping than a horizontal line of direction; and the power or advantage which they have in overcoming the resistance of obstacles in this direction is likewise *mechanically* great, as may be easily demonstrated. On these principles, therefore, single horse carts must be more advantageous than teams; as in the latter cases many of the horses must draw in a horizontal direction, consequently in a way that is inconsistent with their mechanism, and the established principles of mechanical science. This likewise places in the most clear and satisfactory point of view, the necessity of having the wheels in all sorts of carts properly adapted to the size of the horses or other animals employed in them.

But notwithstanding the evident advantage of employing single-horse carts in many districts in preference to waggons and heavy carts, it is obvious, from the nature of the roads and grounds, as well as many other circumstances in other places, that they cannot be generally had recourse to; but that in respect to the construction of them, as well as to most other implements made use of by the husbandman, there must be a difference according to the nature of the situation and the lands and roads on which they are to be employed. It must, however, be admitted, that in most of those districts in which a number of horses are put into one cart, considerable advantages may be derived from a reduction in their weight, and from their being made in a less clumsy manner, as well as from the rims of the wheels being made cylindrical, instead of the usual conical form.

At fig. 1. in plate LI. is represented a *common light one-horse cart* for various uses. Fig. 2. is a close *single-horse cart*, useful for conveying manure or other similar purposes; it is sometimes termed a *coup-cart;* the body resting upon a sort of frame, by which contrivance the contents can be readily discharged. There is a cart made use of in some northern districts for conveying hay and grain in the straw, or any other bulky materials, where only one horse is employed.

Fig. 3. is a front view of the *drag-cart* recommended by Lord Somerville; it is drawn by a single horse in shafts. The too great velocity of the cart, in descending steep hills, is counteracted by a

friction-drag or bar, *b b*, fixed behind by a chain and before by a toothed rack, *b d*, which catches on a staple, by which the pressure is regulated by the driver. The position, or centre of gravity of the load, is also regulated by a toothed rack fixed in the front of the cart at *c*. And a cart of this sort, designed for oxen, in which a more simple method of adjusting the centre of gravity of the load is adopted, has been contrived by his Lordship.

Fig 4. exhibits a view of the *quarry-cart*, a strong low cart for the loading and carrying of heavy stones, and great weights of other kinds.

One horse carts from Scotland are made use of by Mr. Western in Essex, and found to have a vast superiority over the heavy tumbrils which are commonly employed; being useful in the saving of horses in the proportion of two to three. They have harvest frames to put on, and carry three fourths of a waggon load. A cart of this kind is shown in plate LII. The dimensions of which are,

			Ft.	In.		Ft.	In.	
From 1	to	2	11	6	Axle-tree	0	7	circumference
3		4	5	0	Wheel	4	6	diameter
5		6	5	6	Wheels distance	5	0	below
4		6	1	7	Ditto	6	0	at top
7		3	3	10	Box	0	8	diameter
8		5	4	4	Iron streak,	0	$2\frac{1}{2}$	broad
8		7	1	7	Ditto	0	$0\frac{1}{2}$	thick

These carts may be had complete from Scotland, probably cheaper than they can be made here.

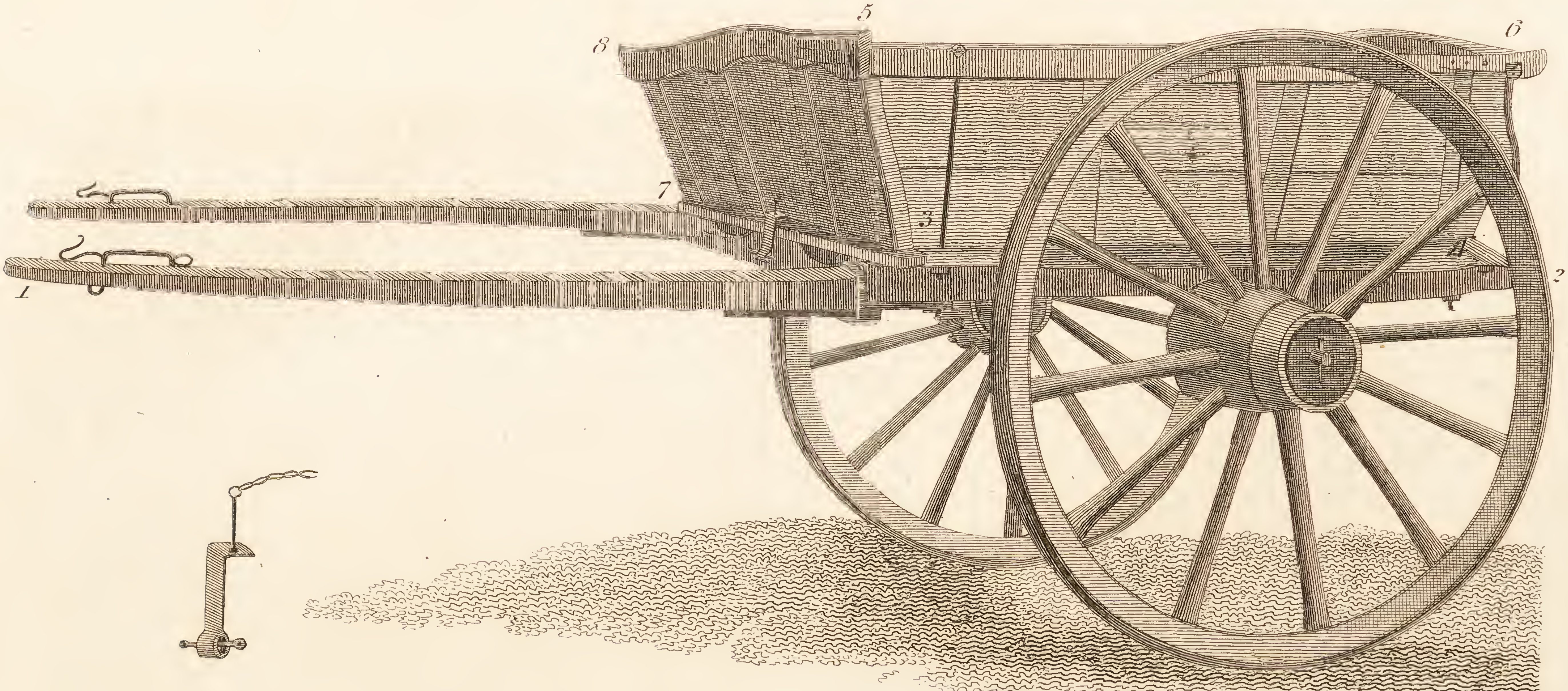
SECTION II.

Farm-houses and Offices.

IN the construction of farm-houses and other buildings necessary for the œconomical and advantageous management of farms, too little attention seems hitherto to have been paid, considering the great practical importance of such objects. It is obvious, however, that the facility and convenience of carrying on different operations must greatly depend on the judicious form and arrangement of such erections. By the commodious distribution of such buildings, servants are enabled to perform more labour, and with greater ease to themselves; as where offices are injudiciously placed, much of their time must, of necessity, be lost in the conveyance of different articles, such as fodder, straw, &c. from one place to another. The methods of distribution, in buildings of this sort, that seem the most advantageous and convenient, under different circumstances, will be more fully considered hereafter.

The size of farm-buildings should in general be proportioned in some measure to that of the farm, and their construction be regu-

Plate LII. Page 66



Neele sc. 352 Strand.

Mr. Western's Scotch Cart.

lated by its nature and situation. Where the farm is merely a grazing one, fewer buildings are required, and these are chiefly of the shed kind, which may be formed in a cheap manner, of such materials as are nearest at hand, or can be easily procured. In such cases the sheds should, however, always have permanent roofs, except they are built in the fields for summer use only. On those grazing farms where the cattle are only housed during the winter, or where a greater number of buildings are employed in winter than in the summer, much expense in roofing such sheds may frequently be saved by erecting walls only, and fixing merely temporary coverings to them for the shelter of the cattle; or by having posts framed, and placed in such a way as to support hay-ricks, or any other sort of rick not to be removed during the winter. By this means a warm roof is afforded, and a convenient situation given for the stacks. This, however, from its being a paltry and slovenly method, is only to be had recourse to under particular circumstances, as where a better sort of cattle-shed cannot with propriety be built.

On such sorts of farms, different sort of sheds should contstantly be provided for different kinds of cattle: where they are intended for store-stock only, they should be open on one side, as the cattle should be kept cool, otherwise they are apt to take cold when they are turned out, which they should always be every day when the weather is tolerable; but if they are intended for feeding-cattle, they should be made much warmer, as in that case the cattle will thrive faster, and there is no necessity for turning them out, so that the danger of their taking cold is avoided.

Different accommodations from these will be necessary for dairy-farms, they being mostly composed partly of grazing and partly of arable land. On these the cow-houses should be so regulated as to suit the number of cows that can at any time be kept; and such other conveniences should be provided as are proper for the dairy business, whether they be managed as cheese, butter, milk, or suckling-farms. For such farms small stables and barns are, in general, sufficient.

And for the arable or corn farm, as partaking in general of both the other sorts, the offices and buildings should not only be much more numerous, but calculated to suit the various purposes of each. The stables should be sufficiently large and convenient for the accommodation of such a number of horses as may at any time be employed in the labour of the farm; and the cow and feeding-houses adapted to the quantity and kind of cattle kept or fed. The barn and granary must also be proportioned to the extent of ground under arable cultivation. Where thrashing-machines are to be erected, the size of the barns need not be so great as in other cases; as neither the height necessary for the flail, nor room for a large quantity of corn in the straw, is required. Besides, these machines not demanding much elevation in the buildings where they are placed, a granary and store-room may often very conveniently be made above them, which cannot be done where the barn is required to be high.

On this kind of farm, convenient buildings should also be pre-

pared for the breeding and management of young animals of different sorts, such as horses, cattle, hogs, poultry, &c.

Farm-houses.—The dimensions of the farm-houses, like most of the other buildings, should in a great measure be regulated by the extent of the farm. It should be neat, airy, and have sufficient accommodations both for the family of the farmer and the business that is to be performed in it. On the ground-floor there ought at least to be a good parlour and kitchen, with back kitchen, which may serve also for a bake-house and brew-house, with closets and other convenient places for depositing different articles; and likewise a dairy, pantry, and a proper place for the purpose of a cellar.

The upper part may be divided into lodging-rooms or bed-chambers, which should be rather large, in order that the circulation of air may be free and unrestrained. The windows are better to be tolerably large than so small as they are commonly made, and the sashes placed nearer the outsides of the walls; for it is evidently a mistake, that they are better preserved from the effects of the weather by having them set so much within the wall as is usually the case, as the wet cannot be so readily dried up. By not properly attending to these circumstances, the appearance of houses of this kind is frequently rendered gloomy and unpleasant. It will also be of great advantage, in respect to health and cleanliness, to have the ground-floors raised sixteen or eighteen inches above the surface of the ground. The kind of roof should be determined by the expense of materials and other circumstances; but hip-roofs, with vents within the buildings, as being cheap, are, probably, in general to be preferred to those where gable ends are had recourse to. It is justly observed by a late author, that hip-roofs require no materials, while gable-ends cause more expense of building, and an unnecessary accumulation of weight upon the end walls; and that vents made withinside of the house are not only less liable to smoak than when in an outside wall, but contribute much to keep the house warm, by acting in some manner as flues, and diffusing heat more or less throughout the whole house*.

The thickness of walls, as well as many other circumstances, must depend on the ease and convenience of procuring materials: where rough stone walls are made, the thickness may be about eighteen inches or two feet; but where the stones are good and properly formed for building with, or where bricks are employed, they may be made much thinner: it should, however, be remembered, that when they are too thin, they are readily penetrated by the heat of the sun in summer, and by cold in winter. Such houses ought, therefore, always to be built of such a thickness as to prevent the effects of these as much as possible.

In the constructing of houses for the purposes of farming, it is evident that considerable latitude must be given; but as architectual ornaments are not much wanted, the principal points to be attended to would seem to be those of providing sufficient conveniences without incurring great expense. Such buildings should be cheap and

* Beatson's Paper in Communications to the Board of Agriculture, vol. i.

simple in their form, and have a regularity of appearance. In constructing new buildings of this nature, it is always a matter of much importance, after the plans have been maturely considered and decided upon, to begin as early in the spring as possible, in order that the walls may become dry before the winter sets in, as in that season they never get properly into a dry state.

BARNS.—It is obvious from what has been already advanced, that the size and construction of barns must be varied in some measure, according to the customs and situations of the places where they are to be erected. Where thrashing-machines and the practice of stacking are properly held in estimation, large barns are quite unnecessary; but on small farms, and where a preference is given to the use of the flail, and the storing of the crops in barns instead of stacks, they should be of considerably larger dimensions, in order not only to admit the necessary quantity of grain to be deposited in them, but to allow sufficient room for the free use of the flail. In such cases they should not, perhaps, be less than eighteen or twenty feet wide, with height and length proportioned to the quantity of materials that are to be stowed. Air should likewise be pretty freely admitted into them on different sides, by means of slides or other contrivances. The construction of the floors should be particularly attended to, in order that they may be firm and dry: the first purpose is probably best obtained by making them of good oak plank; floors formed of clay, and other substances of a similar kind, being liable to crack and be broken up by the different operations that are performed upon them. When floors are made with planks, it is a good method to lay them upon a foundation of bricks, and unite the different planks by ploughing and tonguing. In this way floors are made more secure, and freer from damps, than where they are nailed down to sleepers. The size of the thrashing floors of barns must vary according to circumstances; but twelve feet by eighteen would seem in general to be a good proportion. It has been observed to me by an experienced agriculturist, that next to oak planks, and nearly equal for thrashing-floors, are bricks made of good tempered clay well burned, made four inches thick, and laid edgeways with well beaten mortar. The addition of flues and floors for the purpose of drying might also be sometimes conveniently employed, and would frequently be found advantageous in moist and damp seasons.

Moveable barn floors have sometimes been had recourse to, in order to avoid the constant heavy expense and great consumption of timber that takes place in constructing and repairing those of the usual kind, as well as to prevent the loss of grain on their decaying and getting out of order. Mr. Upton, of Petworth in Sussex, is the inventor of a barn-floor of this nature, which is said not only in a great measure to obviate these inconveniences, but to afford many other advantages; such as those of being drawn upon with great facility by loaded carts or waggons, and providing, when down, comfortable shelter for hogs; and, when turned up, being capable of being made use of as a stable, ox-stall, hovel, or cart-house. It is asserted to be capable of being placed or displaced with great readiness, in the course of a few minutes, by means only of two persons. It is formed

of oak planks five feet eight inches in length, and one inch and a half in thickness; and costs about twenty-three or four pounds. As these dimensions are much less than those in common use, a great advantage is said to be gained in the timber. Besides, planks of deal, beech, or elm may be employed, as they will not, it is supposed, be liable to decay, from there being little or no dampness, and this way much expense be saved. Where timber from the farm is made use of, a further saving may also be made, as they may be constructed of stuff of small scantling, which may be had from short timbers of but little value in comparison to those employed in forming other sorts of barn-floors. It is supposed by the inventor, that these kind of floors will last a hundred years, or as long as the barns themselves; as they are perfectly free from all damps, on account of being so much raised from the ground when laid down. From their being moveable, where there are more barns than one in the same yard, they may be conveyed from one to another, and by that means the great expense of having so many floors be prevented. A representation of this sort of floor may be seen in The Transactions of the Society of Arts.

But though barn-floors of this description may be useful and convenient in particular cases where the farms are extensive, and where, from the want of a thrashing-machine, the flail is employed; in other circumstances, from their complexity, and their requiring considerable room when not in use, they do not seem to have much superiority over those of the fixed kind.

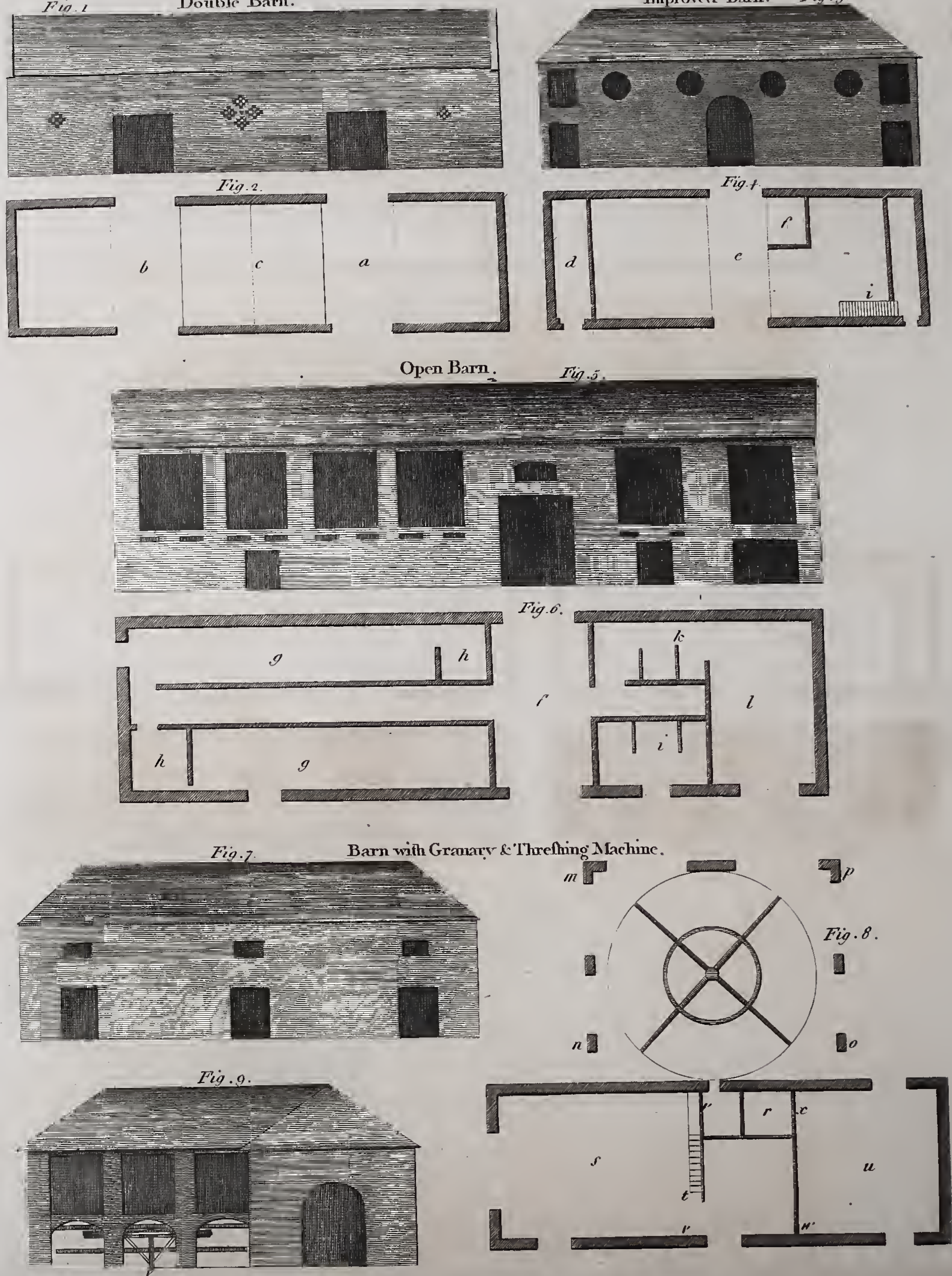
Where the situation of the ground and other circumstances will permit, cow-houses and other farm-offices may be provided on the ground floors, the barns, hay-chambers, &c. being above. The advantages of this mode of construction are, that it saves much expense in buildings, and occupies but little room, while the grain is in less danger of being spoiled by the introduction of dirt or other hurtful substances from the farm-yard, and more secure from the depredations of hogs, poultry, &c. Chamber barn-floors are also said to be more convenient and easy for thrashing upon. These kinds of barns can only, however, be adapted to small farms; and then perhaps may often be attended with inconvenience.

In whatever manner those barns are built that are intended for containing large quantities of different crops, they should constantly be provided with convenient pitching-holes for housing them at, as by this means the danger of injuring the floors by heavy carriages being drawn upon them is avoided, and there is not any necessity for those large and expensive doors that have been in common use: little injury will, however, be done to the floors by drawing the loads of grain upon them, when they are kept well littered with straw; and a man will unload nearly two loads of grain, when drawn into the barn and unloaded upon the mow, while he could unload one at a pitch-hole.

Where thrashing-machines are in use, much less barn room will be wanted: which is a point of much consequence. Barns are either *single* or *double*. The single barns are well known, and those of the double kind may be built according to circumstances.

PL. LIII, 8°

BARNS.



At Fig. 1. plate LIII. is shown the plan and elevation of a large *open barn.* Fig. 1. the ground plan: *f* the thrashing-floor placed towards one end; *g g* cow-houses containing eleven stalls on each side; *h h* calf-pens with sparred floors; *i* a double stall, with two single ones for four cows; *k* two stalls; *l* a work-shop, root-house, or place for keeping implements. The corn in the straw is kept above. The large openings in this barn save much expense in building.

Fig. 3. is a front and end elevation, with a plan of a *barn* and *thrashing-machine* for a three-horse power. It is contrived to winnow and clean the grain while thrashing, and may be made to cut chaff, split beans, hoist the produce up to the granary, and execute various other sorts of work, as grinding, pumping, &c. *m n o p*, fig. 4. is the square for the horse-path, the dotted circle the path. *y* fig. 5. is the upright shaft in its centre; and *z* a granary or store room for straw, hay, &c. over it.

At *v* fig. 4. may be made a communication to afford easy access to the mill when corn is lodged there for thrashing. The mill-head is erected on a floor about seven or eight feet above the ground-floor, to give room for the fanners or winnowing-machine below. It is extended the whole breadth of the barn, and about 15 feet or more towards *s* from the back part of the mill at *q*; by which, and being properly partitioned below, a very necessary and useful division, *z*, may be got for containing the clean corn till drawn up to the granary: the door of this place may be kept locked for safety. The space *r* contains the chaff blown from the fanners, by a door through the partition to render the communication more easy and expeditious from the part *s* where the unthrashed corn is laid: a door might also be made in the partition at *w*; but this is not so necessary, as may be seen where the straw goes, by standing on the thrashing-mill floor, to which there should be steps up at *t*. It may be made also to rake away the straw, and to throw it down to the part *t*, which will save a person raking from the mill. The expense, if made to clean the corn and rake away the straw only, which in general is sufficient, will be about 50*l.* exclusive of flooring, &c. If made to hoist up the corn, to split pease or beans, and cut straw, from six to ten pounds more for each of these operations.

There plans are recommended by Mr. Beatson, as very useful where barns and thrashing-machines are found necessary; which on extensive arable farms must mostly be the case.

There are *moveable barns*, which after the work of the day are drawn forward over the unthatched stacks, which are found beneficial in many cases.

Granaries.—The great object in these buildings being the preservation of a large quantity of grain in a narrow compass, they should not only be strongly built, but be provided with a great extent of flooring on which the corn may be spread; and as frequent stirring or turning is necessary for the safety of the grain, it is obviously of much importance to have been so contrived, that a great deal of the manual labour attending such operations may be avoided. This is done, in some cases, by having them constructed with consider-

ent floors placed in such slooping directions that the corn has a tendency to the centre, and is let out by means of sliding shutters: in others, the same advantage is gained by a number of hoppers situated in such a way as to allow of the grain being moved by merely drawing a slider at the bottom of the granary. Sufficient ventilation, which is highly necessary in these buildings, is, in some instances, provided by having small windows strongly latticed and covered with wire, as well as stout shutters close to the ceilings; and in others a free circulation of air is given by means of a number of air-holes and spouts, disposed in horizontal positions across the buildings. Where it is necessary that the air should likewise pass upwards, that direction may be readily given it by having a ventilator on the top of the granary.

The most convenient form for buildings of this sort is probably that of a square, the size of which may be about fourteen feet. This must, however, be directed by the nature and extent of the farm. They should, when built separately, stand on a sufficient number of strong posts, or pillars of stone, about four or six feet above the surface of the ground, having very strong wooden frames, the insides of which must be filled up with bricks. The girders, joists, and flooring, should be firm and strong, that they may not give way by the great weight of the grain. The whole of the inside is rendered the most complete, by being lined with dry oak, or good deal boards, closely jointed together, and the outside covered over with strong weather-boarding, well nailed to the timber-work of the frame, and properly payed over with pitch or tar-varnish.

But in constructing granaries where the accommodation of the farm is the only object, it is quite unnecessary to pay attention to all these circumstances, as a large quantity of thrashed grain is seldom kept. Neither the same strength or expense of building is required as for those in which large supplies of corn are deposited. It is proper, however, in most cases, that a place of safety for corn sufficient for the reception of one-half of the annual produce of the farm should be provided. Where the custom of housing grain prevails, there is seldom room enough left for erecting a granary within the barn; but where that practice is not regarded, and especially where there is a thrashing-machine, the best and most convenient situation for it is the barn, proper tackle and conveniences for hoisting up the corn being provided. When this useful machine is not however in the barn, the granary may be placed over it with great convenience and advantage.

At fig. 1. in plate LIV. is the elevation of an *improved granary*, *a* the door; *b* the crane for lifting the corn into the upper loft; *d d d* air-holes, to ventilate the different lofts.

Fig. 2. is a section of the inside of the same, *a a a a a* wooden spouts laid across angles upwards, as shown at fig. 3. *b b b b* are ends of other cross spouts in the contrary direction, as seen in fig. 4. *c c c* are half spouts, extending in same manner to air-holes on each side; *d d* floor of granary, three yards square, and divided each way into three hoppers; *e e e*, of one square yard each, making nine in all, as seen at fig. 5. *f* is a larger hopper encompassing the

Fig. 1.

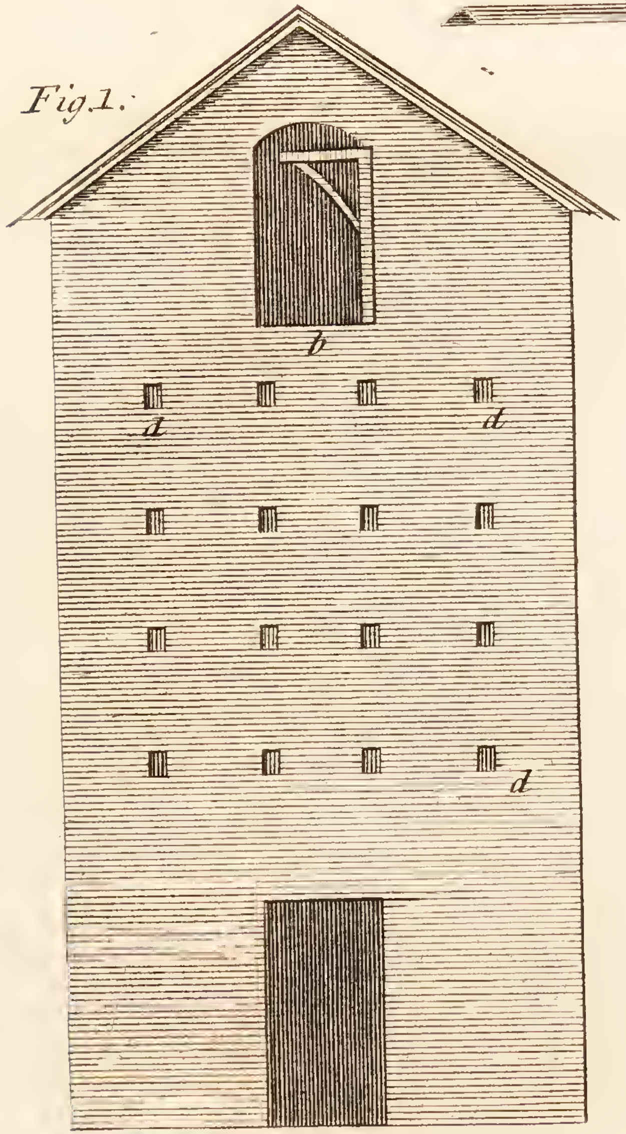


Fig. 3.

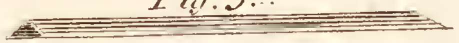


Fig. 2.

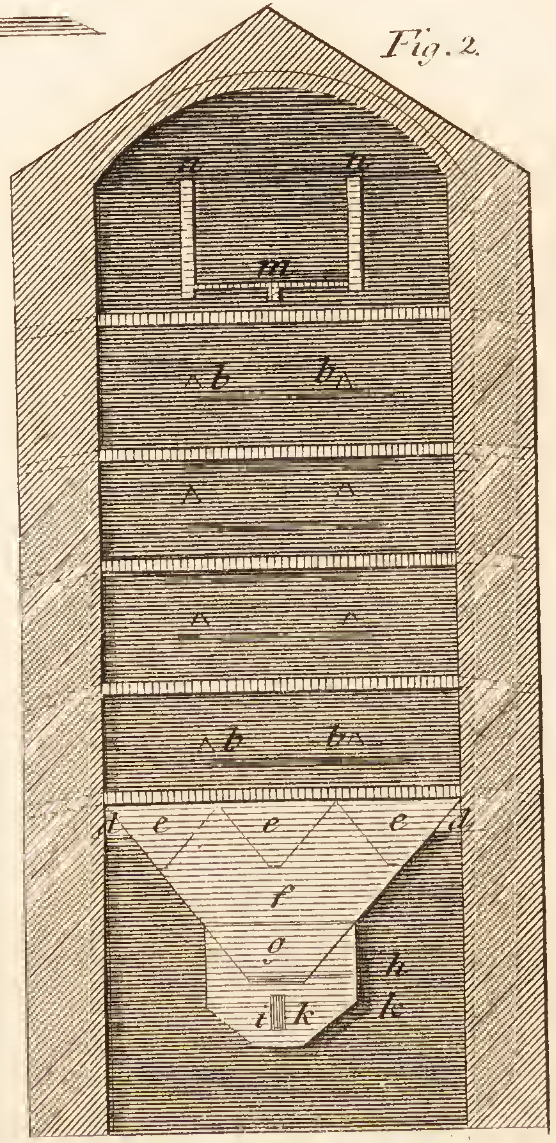


Fig. 4.

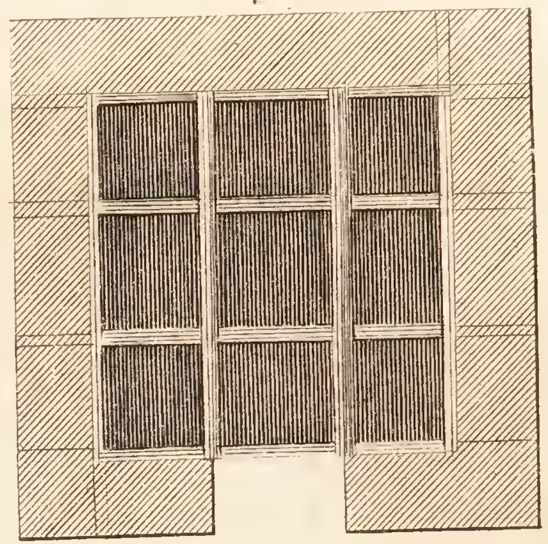
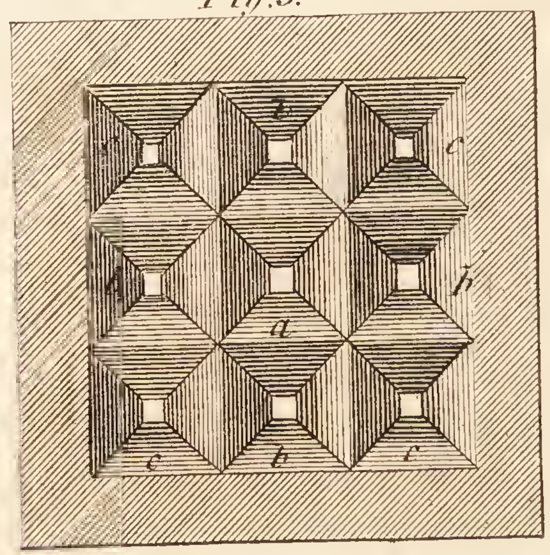


Fig. 5.



IMPROVED GRANARIES.

rest, with slider at *g*; *i* small hopper fastened to this by hinges *k k*, &c. which may be readily loosened from deal box *o o*, the slide handle *b* extends through the side of this box, it is only used for small quantities; *m* small loft for hoisting sacks to, and emptying over rails *n n*, from which the grain falls and passes through the hopper *e e* till it is filled (slider *g* being closed) in which way the granary may be rendered quite full.

STABLES.—In the construction and fitting-up of stables for farm horses, it is not necessary to attend so particularly to elegance as in those which are intended for the reception of horses of other descriptions. It is, perhaps, sufficient to provide them comfortable and convenient habitations: working horses should not, however, be kept in such low dirty hovels as they frequently are; as nothing tends so much to the keeping of these animals in health, as their having dry, clean, and well ventilated stables. They should, therefore, be constructed in such a manner as to keep out the severe cold of winter and the intense heat of summer, and be provided with proper drains for conveying away every kind of moisture and nastiness. The number and size of the windows should be proportioned to the extent of the stable, and be so contrived as to open and shut at pleasure. When it is necessary to save expense, shutters may be adapted to and suspended in the windows by iron pins, on which they may turned as occasion requires.

In the contriving of racks and mangers, regard should be had to œconomy and convenience. The common and too general mode of making them extend quite across the upper end of the stall is not only a bad but by no means a cheap method of constructing them. Besides, in order to save trouble, servants are extremely apt to stuff racks full of hay, however large they may be; from which various bad consequences proceed, and much hay is wasted and destroyed by being either pulled down and mixed with the litter or trodden under the feet of the horses.

The pernicious effects resulting from the practice of suffering horses to be continually stuffing themselves with hay are well known to those who are acquainted with the proper management of such animals, under whose directions they are never allowed to have much hay in their racks at a time. There is also another disadvantage in this plan of fitting up stalls, especially to farmers, as it ought to be their object to preserve every thing;—the hay seeds are totally lost, which, if good, and carefully secured, might be of great utility and value. By the racks having so much inclination outwards, the seeds are also extremely apt to fall into the horses' ears and eyes, which often produce disagreeable effects. From these considerations it would seem that racks should have a more perpendicular direction than is commonly given them, not having a space of more than fourteen or sixteen inches from the wall; the bottom should also be sparred, in order to let the seeds fall down below, whence they may be removed by a sliding shutter or small door. The same advantages may also be obtained by leaving niches in the walls for the racks, on which plan the spars will be equal with the insides of the walls. If the niches and racks be made in the middle

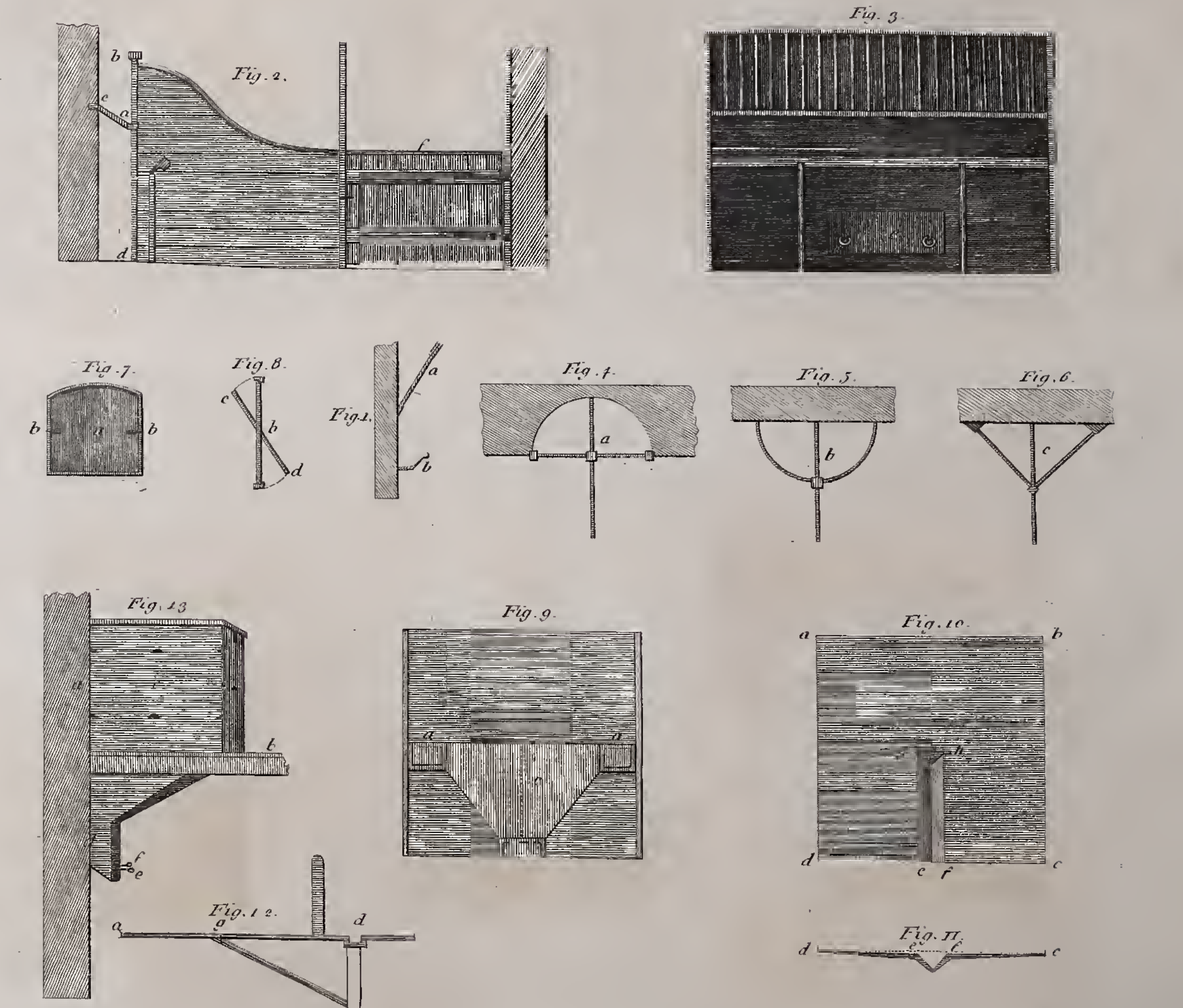
of the stalls, two feet or two feet and a half wide, they will in most cases be sufficient; they should, however, be carried down low enough to admit of a small box or drawer being placed under them, for the reception of the hay-seeds. Racks of this sort may likewise be placed in the corners of the stalls, and be made in such a way as that one niche may serve two stalls. They may also be placed in the angles of the stalls without having any niche, and be made of a semicircular form. But in whatever way they are made, there should constantly be a division betwixt them, which is probably best made of deal. By this means the farmer will be able to know, with precision, what each horse eats; which cannot be done in any other way. Where the racks are put in the corners of the stalls, it may, perhaps, be more advantageous to have them straight than circular; but in whichever way they are formed, the farmer should always have a hatch fixed for each stall, as by that means a great deal of time may be saved in feeding his horses.

It is equally unnecessary in the making of the manger to have it the same width of the stall; as a box or a drawer sixteen or eighteen inches long, and twelve or fourteen inches wide will answer every purpose. It should be so contrived that it may be readily taken out and cleaned whenever it is fouled or becomes furred with dirt. With the fixed mangers this can never be done, however they may be daubed with the saliva issuing from the horse's mouth during the time of feeding, or the discharges proceeding from his nostrils when labouring under colds or other more dangerous disorders.

There is another method of making stalls, which, as being cheaper and more œconomical, deserves to be noticed: on this plan the stable has neither racks nor mangers; the head of the stall is boarded about three feet from the ground, having a space of about two feet from the wall, in which the hay is to be deposited, the horse pulling his hay from below, instead of drawing it from above; which is not only more natural, but prevents the waste of hay, much of which drops down and is lost when the horse eats from a rack; but, by this method, whatever falls is again received among that from which it was taken. But even on this construction it will be necessary to have the bottom sparred, within eight or ten inches of the ground, and a box, hopper, or hay-manger, and drawer, so contrived as to receive the seeds of the hay; where there are double stalls the boxes may be divided in the middle. Single stalls, where they can be conveniently made, should, however, always be preferred, as more safe.

Paving of stables is a matter of some importance, though it has been but little attended to: whether the stall should have a slight declivity or be perfectly level has not, perhaps, yet been fully determined. It would seem, however, to be more natural and easy for these animals to stand and rest themselves on a level surface, than on one that is sloping, as it is obvious that the tendons, or sinews of the pastern joints, must be kept more upon the stretch in the latter than the former case. The chief difficulty in respect to a level stall has been the conveying away of the moisture. This may, however, be well accomplished by paving the stall quite level, and

Horse Stalls & Stable.



only leaving a small drain in the middle, extending within two or three feet of the upper end of the stall. It should not be more than seven or eight inches wide at top, forming an angle at the bottom. The depth of that end nearest the head of the stall should not be more than three or four inches, having as much slope as can be conveniently given it backwards, in order that it may carry the moisture off quickly to the main drain, into which all the stall-drains should empty themselves.

The small stall-drains should be covered with a piece of good strong oak-plank, in which a great number of holes are bored, and which is so fastened as to admit of its being readily raised up and let down: by this means the drains may be washed, and kept clean and sweet.

Main drains may be made at the end of the stalls, or in any other convenient situation, for carrying off the moisture into the general reservoir. If they are placed at the bottom of the stalls, they should not be closer to the stalls than two feet, in order that the stale of mares may get readily into them; which would not be the case if they were nearer, unless the pavement behind the stalls were made to decline a little towards them. These drains need not be more than seven or eight inches wide at the top, but they should be covered with plank in which holes are perforated for conveying away the moisture.

In order to save the expense of making main drains, a shallow open drain may be made in the common way, with which the stall drains may communicate by means of very small grates at the ends.

The pavement or floors of the stalls should have a very slight declination from their sides towards the drains, to prevent any moisture standing on them; an inch or an inch and a half will, however, be quite sufficient.

From having stalls constructed in this way, several advantages will be gained; the horses, by standing on a level, will be less liable to disorders in the feet and heels; and from the great declivity of the drains the urine will be more readily carried away, and not be suffered to spread, and, of course, much litter saved; which is a matter of considerable importance where straw is scarce.

The sizes of stalls are different, according to circumstances; but four feet and a half is the least they should ever be made; five feet is much better. The divisions between them should be high, so that strange horses may not see each other. And where stallions are kept, or young horses required to be left loose in a stall, they should be so inclosed as to be incapable of doing mischief. For these purposes, one or more stalls may be sparred to the top, or doors provided, which may be hung to the back posts of the stable. Where this last method is followed, the stalls serve extremely well for keeping different mares and their foals separate from others.

At fig. 1. in plate LV. is represented the common method of placing the racks and mangers in stables: *a* the position of the rack; *b* that of the manger.

Fig. 2. shows the improved position of racks 14 inches from wall; *a b* spars of rack; *a c* bottom of rack, sparred for seeds to fall down

to *d*, whence taken out by drawer *e* in fig. 3.; *f* a door sometimes made use of in stables.

Fig. 3. is a front view of rack and seed-box.

Fig. 4. represents racks placed in niches in the wall so as to serve two stalls; *a* division betwixt.

Fig 5. shows the same placed in the angles without niches; *b* division betwixt.

Fig. 6. exhibits the form of racks for the angles; *c* the division.

Figs. 7. and 8. shows the manner of fixing the windows or shutters: *a* the front view of window with shutter fitted to it, being suspended on iron pins in the middle at *b b*, on which it turns; *b*, fig. 8. is a side view, showing position of shutter, *c d*, when opened a little.

Fig. 9. represents a sort of hopper, or contrivance, where neither racks nor mangers are employed; it is 14 inches wide at bottom, and sparred for the seed to drop into a drawer: *a a* boxes in the corners for corn; *b b* hay-manger divided by the dotted line *c*.

Fig. 10. is a stall: *a b c d* the ground-plan; *a b* inner end to which the horse is tied. It is paved on a level from *a* to *d* and from *b* to *c*, a small seven-inch drain being left in the middle, as *c f h g*, made to within 3 feet of inner end, forming an angle at bottom, as shown in cross section, fig. 11; depth at *g h* 3 inches, sloping to *d* in longitudinal section, fig. 12. into which the stall-drains pass, these being covered by two-inch plank perforated with holes, secured by hinges or two iron pins, *g h*, fig. 10. The main-drain may be made at *d* in the end of the stall, or otherwise as convenient.

It is also of importance that stables should be better lighted than they usually are; the blindness so frequent among horses has been attributed with considerable plausibility to an excessive stimulus of light on their coming out of a dark stable, where the irritability of the organs of sight has been for hours accumulating, into the full glare of day. Farm-stables, during the summer season, are very generally exposed to the open air; the door or wicket is seldom shut but at night: in consequence of this exposure, flies, which are attracted by the horse-dung, &c. have free access. It will generally be observed, however, that, in such exposed stables, cobwebs also are very numerous: it is unwise to disturb them; the spider should be cherished, as he saves the horse from the irritation of many troublesome enemies. The provision is natural, and should be attended to.

Either in the stables, or very contiguous to them, a place should always be provided for the reception of harness and other articles of the same kind; and likewise a suitable and well-secured place for a corn-bin. If the stable be small, and it is, of course, the most convenient to have the corn-bin in the room above, it should be so constructed as that the proper feed may be regulated and received from a spout in the lower part of the stable. This method saves much time and trouble in going to the bin, measuring, &c. as well as in many instances much corn*.

* Communications to the Board of Agriculture.

Cattle-Sheds, Cow-Houses, *and* Feeding-Houses.—As these buildings resemble each other in many respects, they may be described under the same head. In some cow-houses there are, however, an addition of calf-pens, and slight differences in the construction of the stalls. But although the having calf-pens in the cow-house may occasionally save trouble in carrying milk, it is a plan by no means to be generally adopted, as it causes much uneasiness to the cows, and prevents their giving their milk properly, or sufficient in quantity. It is a much preferable method to have the calves so placed, or at such a distance, that the cows cannot be disturbed by their cries, as by these means the cows will not only much sooner forget their calves, but feed the better, and afford a larger supply of milk.

Cow-houses, or feeding-houses, by a very little management in building them, may be so contrived as to suit either purpose, as necessity may require. They may either be made in the form of single or double sheds, but the latter is probably the better method, as by that means a great number of cattle may be well accommodated at a trifling expense of building. The principal points to be attended to in constructing these buildings, are, that they be capable of free and easy ventilation; that they require little labour in administering the food and clearing away the excrement; and that the stalls be so contrived as to keep the cattle perfectly dry, airy, and cool, and have convenient and suitable drains and reservoirs for the reception of urine and dung.

Those who have had much experience in the management of cows, know that a free circulation of air is as highly necessary in these houses as in stables. In low and close buildings, where a great number of cows are put together, they are extremely liable to be disordered by the condensed perspiration and fumes arising from their respiration, as well as from the cold proceeding from the quick evaporation that takes place in such cases. In this way cattle are frequently prevented from fattening so expeditiously as they otherwise would do. Where many cattle are together, the sheds in which they are kept would, perhaps, be best quite open behind them, except for feeding cattle, which are well known to thrive faster when kept rather warmer.

When more free ventilation is necessary, which is shown by the wetness of the timbers above, it is probably the best way to procure it by making additional air-holes in the roof or other convenient places in the buildings. Where there are gable ends, windows may be made high up in them, with moveable boards so contrived that they can be opened or shut as occasion may require. By these means advantages are gained, not only in respect to the health and fattening of the animals, but the duration of the building itself; for wood which is frequently wetted and dried, in the way we have just noticed, decays with astonishing rapidity.

As any one the least acquainted with animal œconomy must know that it is utterly impossible for such cattle as are kept in a state of constant excessive perspiration to feed well, and consequently get fat with expedition, which are the circumstances on which the farmer's

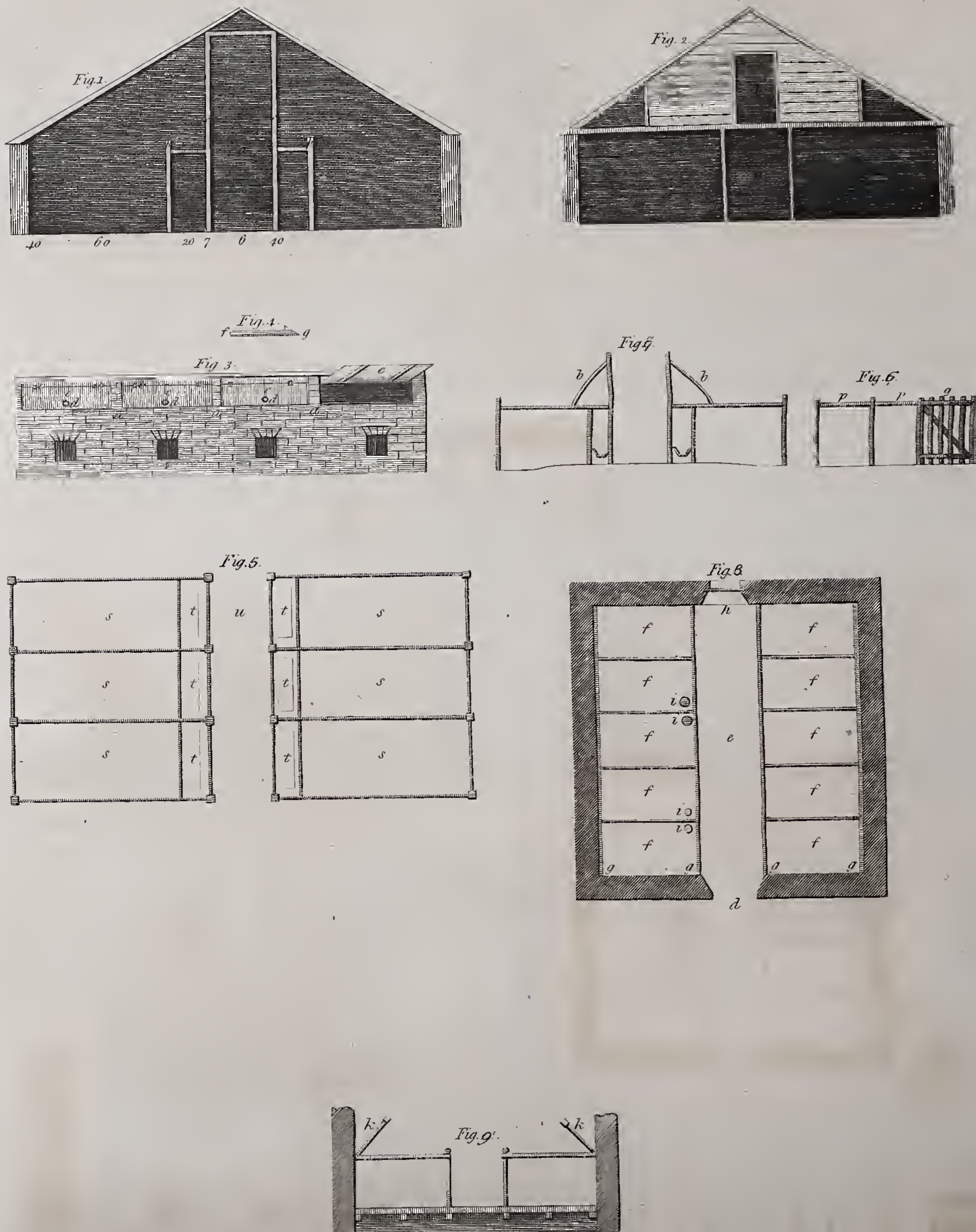
profit and advantage greatly depend, more attention should certainly be paid to these matters. An extensive feeder in one of the midland districts, however, assures us that he has, from long experience, always found such cattle as feed the quickest, whether within doors or without, to be those which are generally in a state of moderate perspiration.

In regard to the most convenient plan of construction for saving expense in labour, and for allowing of the most ready and expeditious mode of clearing away the dirt and nastiness which is produced, there are many things to be attended to, but chiefly those of the form and arrangement of the internal parts. It is a very common method to have posts placed along the sides of the wall at the distance of about three feet from each other, to which the cattle are fastened; a space of three or four feet being left next the wall for the reception of the food. This is, however, a very injudicious method, because the feeder is constantly under the necessity of going among the cattle in order to give them their food; except indeed where they are fed from the outsides of the building, which is both an inconvenient and tedious method of proceeding. In feeding from without, too, through holes made on purpose, there are many objections. At some periods, as in rainy weather, and when there is a great fall of snow, it will be almost impossible to give them their fodder.

The most easy method to avoid these inconveniences in single sheds, is to leave a sufficient space before the heads of the cattle for the feeder to go, with such vehicles as contain the food, by which means he will be enabled to distribute it with facility. In double sheds, which are unquestionably the most proper, œconomical, and convenient buildings, the same advantages are obtained by making the cattle to face one another, and leaving a space of about four feet as a passage for the person who feeds them. By this arrangement a less extent of building is necessary, and much less destruction of fodder incurred, especially where a loft is provided in the roof for depositing the provender and other purposes. This should also be done in the single sheds; and the easiest mode is that of having covers or doors opening by means of hinges without, by which the different articles of food may at once be thrown in from the cart or waggon. In these cases the sheds ought, perhaps, to be a little higher than they are commonly made, and the inside be covered above the cattle with boards. But double sheds, a very intelligent feeder assures me, are not only the most improper and inconvenient, but the least œconomical, and most expensive in their construction; being attended with many inconveniences, and no advantage, that he knows of, except that of saving a little, and but a little, room. Sheds for cattle should never, he thinks, have lofts over them, as by that means the cattle are kept too warm and close; and unless the floor over them is quite close, which is still worse for the cattle, the fodder that is laid there is frequently spoiled by their breath. He would always recommend single sheds open behind, about twelve feet within, including a gang-way of two feet before the heads of the cattle, for the purpose of feeding them; three feet, or three feet two inches, he has always found sufficient space for each beast, except they be very

PL.LVI. 8°

DOUBLE CATTLE SHEDS.



large indeed. It is also very convenient, he says, to have a small room, about the middle of the side of the shed, with a door into the gang-way, for the purpose of getting the hay into from the stacks, which should be placed as near thereto as possible.

The kepping of cattle clean, dry, and free from disagreeable effluvia, is not only a business which demands much attention, in so far as it tends to preserve their health, but which interests the farmer in a high degree, from its taking up much time that might be otherwise employed. It is therefore of the greatest importance to have these kinds of buildings so contrived that they may require as little labour as possible in removing dung, &c. These things should, therefore, particularly occupy the minds of persons employed in making such erections. Where, from situations and circumstances, a convenient place can be provided behind the cattle, for depositing the dung at once, it will be by far the best way, as much labour and expense in wheeling, &c. will be saved, and the dung will not be injured by it. Besides, it will be prevented from being scattered about the farm-yard, by which considerable loss is often sustained.

The proper construction and paving of stalls tend very materially to render the cleaning of cattle easy and expeditious; though in some places stalls are scarcely employed at all; the cattle either not being bound, or merely bound to stakes without any divisions being made betwixt them, while in others they are confined separately in narrow stalls by rails, or the stalls are only made with short divisions. Double stalls properly divided, and boarded sufficiently high to prevent the cattle from looking over them, are, in general, to be preferred; but stalls of this kind are certainly more expensive, and in many instances unnecessary. In feeding-houses each stake should have a box or trough for meat, and in the middle a convenience for holding water, in order to serve the beasts on each side, which, in many instances, may be filled by means of a pipe from a cistern or other place where water is kept. These boxes or troughs may be made of either wood or stone, and be joined together or separate, as may be thought the most convenient. Above these troughs a perpendicular rack should be placed for containing hay, straw, &c. But it is, perhaps, better to have the racks moveable, and connected with the gangways.

In paving the stalls, the same directions should be attended to as in that of stables; for, where cow-stalls are paved with too great a declination, the animals always stand in a very uneasy and uncomfortable manner; which is very prejudicial to their becoming fat, or feeding well.

Proper drains and reservoirs for the reception of urine, &c. are also of the greatest consequence, as without them it is utterly impossible to preserve the animals that are kept in such houses so sufficiently clean and sweet as is necessary. Besides, the moisture or juice, which is continually issuing from dung and other substances in a state of dissolution, must be received and detained in them, or the farmer will sustain considerable loss in point of manure.

These sorts of sheds are either single or double, the first of which are well known.

At fig. 1. in plate LVI. is shown a *double shed* for cattle, in which *a*

is the passage before the heads; *b b* stakes to which they are tied up; *c c* posts or pillars for the purpose of supporting the roof. It may be an advantage to have racks when necessary. Fig. 2. represents another form of double shed, in which *a* is the gang-way before the cattle; *b* a room over, which may serve many different purposes. Fig. 3. is an internal part of the sheds for containing the fodder. In single sheds it is contrived so as to admit its being put in from the cart, by having covers that open on hinges; the roof being supported on pillars *a a a*, three or four feet in height, placed on the wall at the distance of eight or ten feet from each other; *b b b* the hinges; *c c c* the covers; *d d d* rings for pulling them open by; *e* one of the covers open, and held by the catch *f g*, fig. 4. which is moveable on a small pin, the heavy end, *f*, within the fixed boards, and the other, *g*, without, to catch in a hole made for the use in the cover when opened.

Fig. 5. plans of narrow stalls, where the cattle are not bound, but confined separately in them. *s s s* the stalls; *u* the passage betwixt; *t t t* the troughs from which the cattle feed.

Fig. 6. the elevation of the hind part of these stalls: *p p* rails to lift out at the ends; *g* a little hatch or gate sometimes made use of.

Fig. 7. is a section of these stalls: *b b* short rails or braces to keep the cattle from touching with their horns.

Calf-Pens.—In the construction of calf-pens there are a few things that ought to be kept in the mind of the builder. Though they should not, as has been observed, be situated in the cow-house, they ought not to be at an inconvenient distance from it. Great attention should likewise be paid in laying the floors, as it is of much importance in rearing such animals to keep them dry, clean, and warm. Calves, when intended for rearing, should always be kept dry and airy, and rather cool, or at least not over warm. By laying spars about two inches broad upon joists, at the distance of two inches from each other, so as to raise the floors two or three feet from the ground, according to situation, they will not only be kept perfectly dry, as the moisture will be drained off, but fresh air will be admitted under the floor, by which means the noxious unpleasant smells too frequently met with in calf-houses will be removed. It would also be a good practice to have stalls or divisions in the calf-pens, so that each calf might be kept separate; by which means they would be much sooner fattened, and more secure from mischief. Partitions, if about three feet high, and made of any thin light wood, might be so contrived as to be moveable at pleasure, and capable of being increased or diminished according to circumstances. In these pens, conveniences may be placed for milk, where calves are to be reared, and slight racks for a little hay in the higher parts of them; as by these means the food would be more equally and more certainly administered to these animals.

At fig. 8. in plate LVI. is the plan of a double *calf-pen*. *d* the door; *e* the passage between the pens; *f f f* the pens, in which the situation of the partitions is seen; *g g g g* four joints in which are holes for pins to keep the partitions in their places; *h* a door or window at the end, and other air-holes may be necessary; *i i i i* troughs for

milk. And fig. 12. in the same plate is a section of these pens; *k k* the position of the racks.

Dairies.—The advantages of good dairy management are, in common, so great, that every farm should have suitable accommodations for carrying it on in a degree proportioned to their kind and extent. Dairies are of three different kinds: the butter, the cheese, and the milk-dairy. The last is principally in use near large towns, where the milk is carried as soon as possible to be sold. A good butter-dairy should have three apartments: a milk house, a churning-house, in which there should be a proper boiler, and other conveniences for scalding and washing the vessels, and a place for keeping them in, as well as for drying them, when they cannot be put out of doors.

The cheese dairy should also consist of the same number of rooms, namely, the milk house, the scalding and pressing-house, and the salting house. The cheese-room is commonly at a distance, but it might be very conveniently made over the dairy. For the milk-dairy, a good milk house, and a convenient place for scalding, cleaning, and keeping the utensils in, that they may be sweet, are only necessary.

As a proper temperature of the air is of very great importance, the situation of the dairy should be such as that it may not be exposed too much to the heat of the sun in summer, or the coldness of the air in winter. The inconveniences attending the latter, however, being more easily removed than those of the former, a northern exposure should be preferred, and one which is covered as much as possible by the shade of trees or houses. If situated so that the sun has no influence on any part of it, it is the better. Where no rooms are made above the dairy, the covering may be of thatch placed over tiles; but it is better to have rooms above, in which case the nature of the covering is not of so much consequence. Thatch coverings in such cases are, however, certainly the best, as being the warmest in winter, and coolest in summer; but tiles in these circumstances are unnecessary, and they prevent the thatch from being properly fastened to the roof, and by that means to be liable to be blown off. The thatch should be properly parged with lime-mortar on the inside, to prevent any dust falling upon the milk.

Stone walls in such buildings are always to be preferred to brick, as being less permeable to the heat of summer and the coldness of winter.

In regard to the proper height of the ceilings of dairies, different opinions are maintained. Eight feet, or eight feet and a half, would seem to be a sufficient height for every purpose. But of whatever height the ceiling of the dairy be made, the windows should always reach to the top, in order to prevent the stagnation of air near it, and be latticed, with slight frames adapted to them, on which gauze must be stretched, to permit a free circulation of air, and at the same time keep out flies, and other animals of the same kind.

Free-stone flags are the most suitable for floors. They should be made quite smooth, and well jointed; but where these cannot be had, or are too expensive, square paving bricks, well laid and jointed,

may answer tolerably well. Marble and other expensive substances are sometimes employed, but they come much too high to be used in common dairies; but of whatever materials the floor may be composed, it should always be laid in such a manner as to decline towards the middle, or some other more convenient part, for taking off the water with which it may be washed or flooded in hot seasons. There should be a well, with a pump, for this and other purposes, either in the dairy, or as near to it as possible.

If the dairy be small, it will be sufficient to have it fitted up with neat shelves, for the reception of the vessels that contain the milk; but where it is on a large and extensive scale, it may be fitted up with such cisterns or coolers as are sufficient to contain a meal's milk, when not allowed to be deeper than three inches. They may be lined with lead, or made of marble or slate, where it is to be had; excellent ones are made by Mr. Hind, at the Slate Pits, at Swithland, near Leicester, of the last sort of material; but from the former there will be little danger, if they be kept sufficiently clean*. These coolers should be furnished with a plug at the bottom and a cock to let out the milk, or the water when they are washed. At the backs of them, too, there should be cocks for the purpose of letting in water to clean them with. A large cock ought likewise to be placed in some convenient part of the dairy, for letting water upon the floor when it is necessary to clean it, and to cool it in hot seasons.

With a view to afford a necessary degree of heat in the winter seasons, flues may be made to proceed from the fires either in the churning-room or the place where the utensils are dried and kept in proper condition. These flues ought to be constructed in such a manner that the heat may be regulated as occasion requires, or wholly stopt if necessary.

Both the walls and the ceiling should be so plastered that there may be no cracks or crevices for the lodging of dust or insects. Sometimes a part or the whole of the wall above the coolers is set with small glazed Dutch tiles, which give the dairy a neat and clean appearance.

The room for churning in should be as near as possible to the milk-house, and be provided with a fire-place and furnace, and also a proper boiler for heating water to scald the different vessels, as well as other purposes. It is an additional convenience if a pump can be had, with suitable contrivances to it for filling and emptying the boiler.

The place in which the utensils are kept should likewise have a small fire-place in it, in order that they may be well dried, in case they cannot be put out into the open air, which is always the best method, stone shelves being placed on the outside for such purposes. But strips of wood placed in this direction instead of stone shelves would probably be much less expensive, and

* Very good coolers might probably be made from the beautiful black slate lately found on the estate of Lord Penrhyn, in Wales, as it may be raised to any thickness, and is capable of receiving a polish nearly equal to marble.

PL. LVII. 8.°

DAIRY HOUSE & IMPLEMENTS.

Fig. 3.

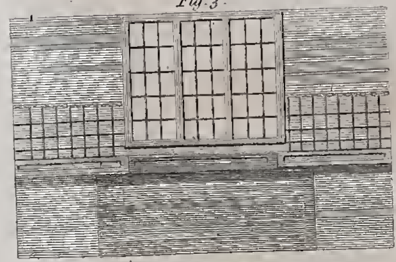


Fig. 2.

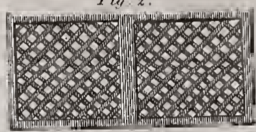


Fig. 1.

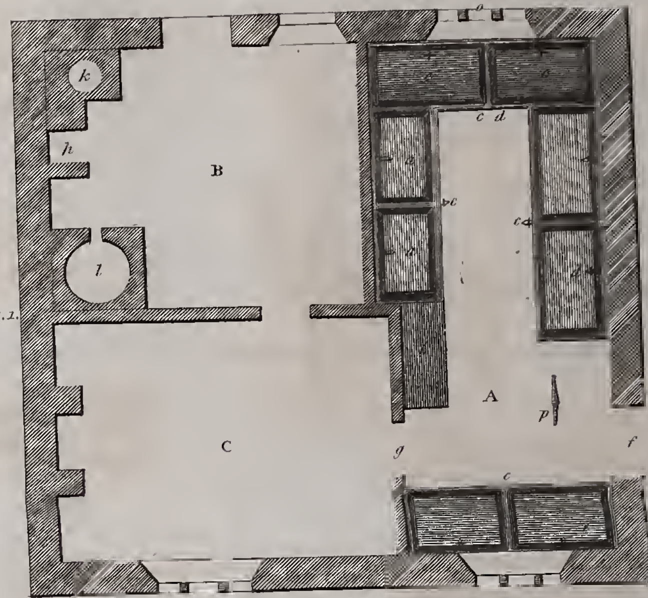


Fig. 4.

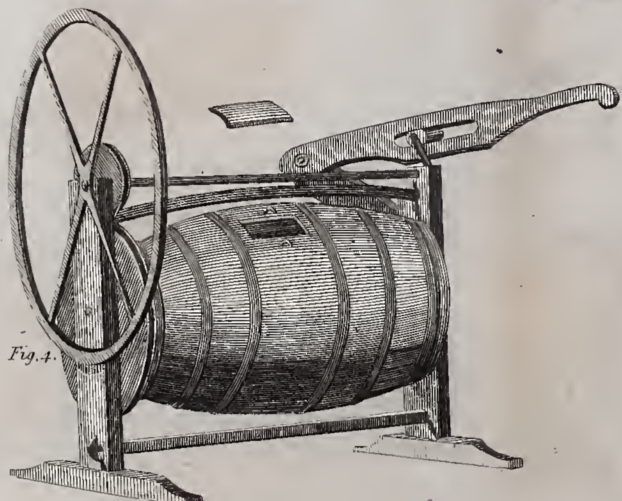


Fig. 6

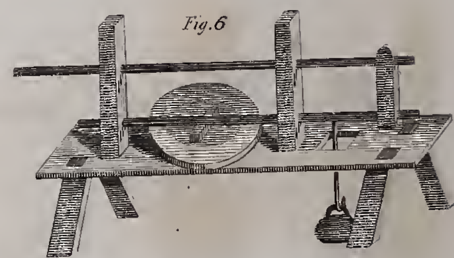


Fig. 5.

the vessels be found to dry much better upon them. The cream may be put into this room when the weather is cold, or just before it is churned, which is frequently found to be a good practice. In all the chimneys the greatest care must be taken to prevent their smoking, as when that is the case it is highly prejudicial to the milk and cream, as well as the utensils of the dairy.

For the cheese dairy, the milk-house should be nearly on the same construction with that which has been just described: all the milk being seldom made into cheese, there may be a necessity for coolers. Where the contrary is the case, it may be more convenient to have shelves for the milk-vessels, by which means they will always be at hand for carrying milk to the cheese-tubs, or copper when it is to be made warm.

The pressing or scalding room may be made on the same plan as the churning-room described above; only it must be provided with a good cheese-press, which is much more handy than having it at a distance, as is often the case.

It would, perhaps, be still more convenient to have one room large enough to serve for the several purposes of pressing, scalding, and salting-house. The salting-room should be laid with flags, and made so as to readily carry off the water when it is washed out. It should also be provided with a strong table or shelf, for laying and turning the cheeses upon, until they are in a proper condition for being put into the cheese-room. A convenient place should likewise be made, near to or in the house, for containing small sand, for the purpose of scouring the dairy-shelves and utensils.

The cheese-room may be made over the dairy; but it is most commonly made above the cow-house or kitchen, the warmth of such places being supposed to promote the ripening of the cheeses.

At fig. 1. in plate LVII. is given the representation of an *improved form of dairy*, in which A is the milk-house; *a a a* the coolers; *b* a slab for laying butter upon after it has been made up; *c c c* cocks for drawing off the milk from the coolers, one serving two coolers by the contrivance of a short piece of leaden pipe from the holes *o o o*, which are stopped by the plug *p*, being made sufficiently long to extend above the surface of the milk; *d* a large cock to throw water upon the floor, which is laid with a little slope from that part; *e e e* cocks at the back part of the coolers for letting in water; *f* a door latticed, as shown at fig. 2; *g* another pannelled door. B the churning room; *h* a fire-place; *k* a boiler; *l* large boiler or copper for scalding implements or other uses. C a room for airing or drying utensils, and may be used as a laundry. Over these may be made servants' lodging-rooms, if necessary. And at fig. 3. is a view of the inside of the dairy at the end Q.

The implements which are principally necessary in houses of this nature are those of the Pail, Churn, and Cheese-press kinds; in the former of which various improvements have lately been introduced, by which they are rendered not only more convenient, but capable of performing their work with much greater facility and dispatch.

At fig. 4. in plate LVII. is shown an *improved barrel-churn*, with

a wheel. Fig 5. an *improved churn*, put in motion by a crank and lever, which is very convenient and useful where large quantities of butter are not made.

Fig. 6. is a *cheese-press* on the principle of the lever. Screw-presses are, however, common in most dairies, as being more convenient and more easily managed. In these cases the stone, or weight, is fixed in a frame of wood; in the upper part of which the screw acts so as to readily wind it up or let it down as may be necessary.

Farm-Sheds.—These buildings are often extremely convenient and proper for various purposes of the farm. They are cheap and simple in their construction, and erected without much labour. Places of this kind are most commonly made so as to lean to and rest against the walls, or other parts of buildings, the easing or lower part being supported by a slight wall, posts of wood, or stone pillars. Frequently, too, the whole of their roofs is sustained by posts or pillars. These sheds are of much utility for preserving all the larger sorts of farming implements from the effects of the weather, as well as for the protection of young animals of different kinds, such as horses, cattle, sheep, &c. when they are turned loose in the farm-yard. They might also be so contrived as to admit of stowing large quantities of different kinds of hay, when brought from the stack for the use of the cattle; by which it would be extremely ready and near at hand for foddering with; but not for depositing it in when first brought from the field, as in such case it would be much less valuable. They may also be applied to various other uses; which abundantly shows their importance in the œconomy of farm-buildings.

Straw-Houses.—Where the practice of stacking straw prevails, these houses are not so essentially necessary: it is, however, always advisable to have some place or other in which a small quantity can be deposited for the daily support of different animals, as by this means much time, as well as straw, will be saved, and there will be much less dirt and litter about the yard. Places for this purpose should always be situated as conveniently as possible for the stables and cattle-sheds.

Root-Houses.—Where a number of cows or cattle of any kind are fed on winter roots and vegetables, such as carrots, turnips, potatoes, cabbages, &c. it is highly necessary to have houses of this sort, in which they may be placed and kept near at hand, when the season is bad, for the daily supply of the cattle. But some vegetables, such as cabbages, will not bear to be laid up in houses in any considerable quantities, or for any considerable length of time, as they are apt to run quickly into the state of fermentation, and become putrid. This sort of sheds should constantly be placed so as to be the most convenient for conveying the food to the animals that are to consume it.

Poultry-Houses.—In every case, where any considerable number of poultry are kept, a place should be provided for confining them in. This is particularly necessary for the farmer, as he may otherwise not only sustain considerable injury by their depre-

dations, but lose much of the profit arising from them, by their being frequently killed, and their eggs lost in the hedges and other places. As a free and uninterrupted circulation of air is highly necessary to the preservation of the health and feeding of poultry, they should not be cooped-up in dark restricted hovels, but have a large suitable place constructed entirely for their use. It is not, perhaps, yet well ascertained, whether different sorts of poultry do better when kept separate and distinct or not, though it would seem to be the case, as the œconomy and habits of each are different. Where sufficient room can, therefore, be spared, it will be the properest method to have the entrances, as well as the roosting and breeding-places, of each sort, distinct from the rest; though the whole may be contrived so as to be under the same roof, and consequently be fed from the same place, which will save time and trouble. If room can be had, there should likewise be a yard proportioned to the number provided for the whole stock, which should be fenced in in such a way as to prevent their flying over, or getting through, and which should communicate with the poultry-house, and be well supplied with water. If a pond or stream of water can be had, it is so much the better.

By these contrivances it will be found that poultry of all kinds may not only be bred and reared with much greater facility, but be kept more free from disease and accidents.

Hog-Sties.—In the construction of these there is much diversity; but perhaps in general, where only a few pigs are kept, little more is required than that they be made sufficiently dry and warm, and that small yards or areas be provided for the holding of troughs and the reception of the food. It is probably the best and cheapest method in these cases to make them with shed-roofs, and neither very high nor wide; six or seven feet wide is quite sufficient for a division. But where the swine-system is conducted in an extensive manner, much attention is necessary to the form and construction of the sties, both in respect to their convenience in the management of the hogs, and the important circumstance of raising manure. Mr. Young considers the circular form, or, on account of the greater expense of masonry on that plan, the angular one which approaches nearest to it, as the most advantageous and convenient. Whatever form is adopted, there ought to be a proper number of divisions, in order to suit different purposes, and contain different sorts of hogs. Some should be made for sows when with the boar, others for brood hogs, and for farrowing, weaning the young pigs, and fattening in, &c. The advantages and expense of building a piggery on the circular plan are shown in explaining the methods of management which are the most beneficial with swine.

As hogs are apt to slop over and spill a part of their food by getting their feet into the troughs, there should be a thin piece of board nailed on the back part of the troughs, so as to come forward in a way to only just admit their heads; and they should have a sufficient number of divisions, each rising a little above the top of the trough. Many other sorts of troughs may likewise be easily con-

trived for preventing the waste of food, and it may be done by placing them in the divisions of the yards.

It would be of great advantage to have conveyances for water, such as open spouts for instance, passing through the sties, in order that they may be frequently washed and kept clean, and that the hogs may drink when necessary.

In the construction of these buildings, care should likewise be taken that the animals be fed conveniently, and without going among them. Where a few swine are merely kept for family use, they may, if situation will admit, be fed with great ease and facility by having holes and troughs placed in the walls of the back kitchen of the farm-house. By this contrivance much stuff, which would otherwise probably be lost, may be conveyed to them. Where a great number of hogs are constantly kept, it is advantageous to have a furnace and copper near to the sties, for preparing their food. In treating of hogs these buildings will be more fully considered.

At fig 3. in plate LVIII. is exhibited the form of a *hog-trough* contrived so as to prevent waste by spilling, from the hogs getting their feet in, by having a piece of deal nailed on the back of it.

And at figs. 4. 5. and 6. are shown the method of making the division in hog-troughs, which need not go to the bottoms.

Fig. 7. represents another method of preventing waste, by having a shallow trough below, and above large deep troughs with open bottoms, to let the food pass as it is consumed from the trough below. Where liquid food is employed, the lower trough may be of stone, as shown at A.

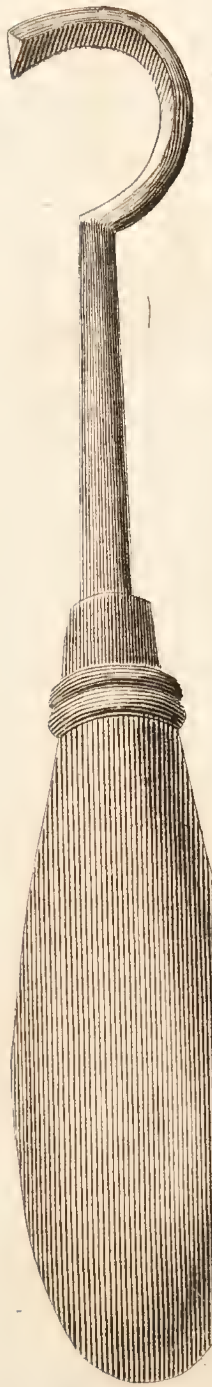
Coal and Wood-Houses.—Firing being every where an article of considerable expense, it is necessary that a proper and convenient place should be provided for it. Houses or yards for this purpose have most commonly been made without roofs or other coverings; but as coals are much injured by exposure to the sun and weather, they ought always to be well covered. They are more durable, however, when made wet before they are used. Where large quantities are consumed, the large and small coal should be put separately; and places made for putting cinders and such wood as has been broken up: if peat or wood only be used, these houses should be much larger, and better secured in the roofs. These places should always be situated as conveniently as possible for the kitchen.

Work-Shops.—Where the farm is extensive, a place of this sort is extremely useful and convenient for making and repairing different kinds of tools, as well as for preserving materials ready seasoned and prepared for the purpose of constructing or mending ploughs, harrows, carts, wheels, and other implements of husbandry. By this means the farmer is sure of having his timber in proper condition, and always ready to his hand. These shops should always be provided with a good set of carpenter's tools, a bench to work upon, a lathe for turning different things, and a convenient grind-stone;—and a blacksmith's shop may often be necessary on farms of very considerable extent.

It would likewise be of advantage to have a place for timber, and

STEAM BOILER &c.

Fig 11



Dublin Potatoe Set Scoop.

Fig 10

Mr. Stark's Potatoe Set Scoop.

Fig. 5.

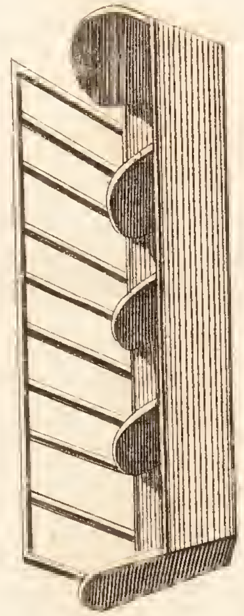


Fig. 6.

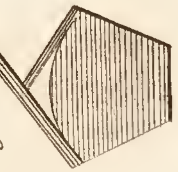


Fig. 9.

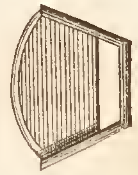


Fig. 8.

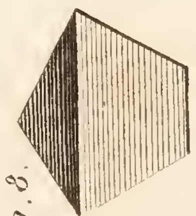
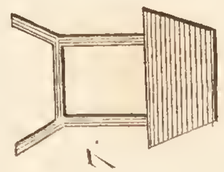


Fig. 7.



Steam Boiler for Potatoes.

Fig. 1.

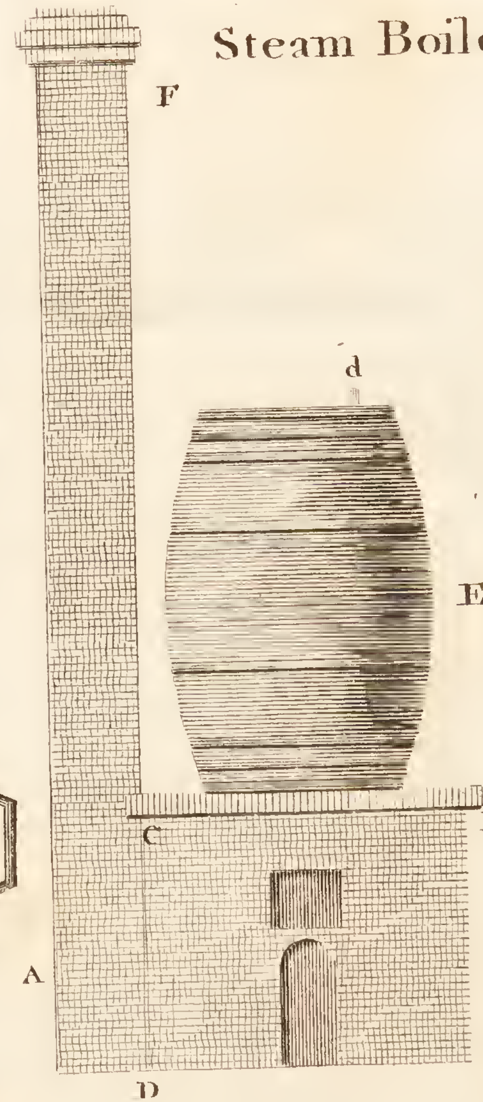
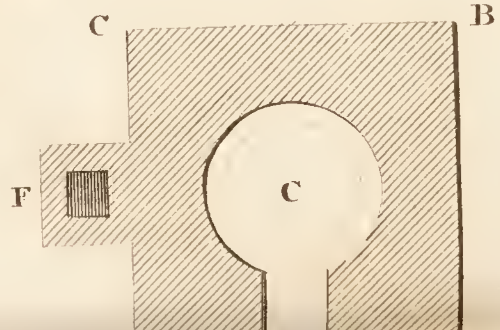


Fig. 2.



a saw-pit near at hand. The latter might be made under the same roof with the work-shop, if convenient. In the former, all sorts of wood or timber and the broken or worn out implements should be deposited.

Tool-Houses.—The smaller sorts of tools, such as spades, forks, rakes, scythes, &c. &c. being exceedingly liable to be lost, a place should be provided for laying them in when not in use. Sacks, ropes, twine, nails, and old iron, may also be laid up with them. For this purpose the place need not be large, but it should be dry and free from damps. Of this room the master of the farm should always keep the key, in order that he may readily know where to find such tools, or other articles, as he may want.

All the other larger implements of the farm should likewise be laid up in places of this sort, when not in use, after having the dirt well cleared from them, and not be left exposed to the weather, as is too frequently the case. The saving afforded by this attention is very considerable upon a large farm, and the trouble of doing it but very trifling.

Store Rooms.—The farmer, in particular situations, frequently finds it necessary to store up some of the produce of his grain; such, for instance, as meal, in order to get a better price for it; he should, therefore, be provided with a suitable store or meal-room. These rooms should be as dry as possible, and perfectly secure from vermin. An upper floor is probably the best for such purposes, provided the articles can be conveniently and easily conveyed to it. They ought to be furnished with strong well-made chests, for holding the meal or other articles that may be put into them. If meal, it should be well-rammed or pressed down, by means of a proper beetle, in order to make it keep sweet and well.

Farm Servants'-Rooms.—Where farms are extensive, and, of course, many servants required, especially if they be unmarried, proper and convenient accommodations for sleeping, and, where they find their own provisions, for preparing and dressing them in, are not only necessary, but highly advantageous both to the farmers and the men; they save much time, which would otherwise be lost in going to their meals, and keep them together, sober, steady, and ready for their business. Besides, the men in this way are much more comfortable, and live considerably cheaper, than where it is the custom to go to public-houses, or other such places, for their meals, as is much the case in many of the more southern districts. Where the method of eating at the musters is followed, the eating-rooms should be so situated that they may be overlooked with facility; but the lodging-rooms are the safest, perhaps, when made in a building quite detached and distinct from the other houses and offices.

Whatever situation may be fixed upon for these conveniences, the ground-floors should always be of stone or brick, and the upper ones made with plaster, as in some of the midland counties; or brick, which is easily and frequently laid. In constructing these floors, the joists are laid in the common method; then a strong sort of reed is fastened down to them, upon which the plaster is

placed. If with brick, the joists are laid twelve inches apart, and the bricks made to reach from joist to joist, and joined at the sides and ends with well-wrought mortar; it might also be advisable to have the stairs made of the same materials. In order to save this last article, there is, however, sometimes a slight coat of common lime laid on first, so as just to fill up the inequalities; the plaster being afterwards spread about two inches thick upon this; in doing which great expedition must be used. Where reeds cannot be procured, small thin laths may be employed in their stead: these are, however, more expensive. In the districts where this mode of constructing floors is practised, the plaster is prepared and sold at the kilns for about six-pence the bushel; and the expense of putting it on, if burnt and prepared, is about five-pence the square yard.

The places for the sleeping of servants may be so contrived as that several persons may be accommodated in a narrow compass; this is done by the beds being fixed and placed in double tiers one above another, four beds in this way occupying the room of only two on the usual plan. The approach to the upper beds may be rendered sufficiently easy and convenient, by having proper steps or stairs; and may be made either on the same side with the other beds, or on the contrary, as from situation, and other circumstances, is the most suitable. It will however be proper, and even highly necessary, where so many persons sleep in so small a compass, that the windows be pretty large, and so contrived as to readily admit of a free circulation of pure air*.

Besides the buildings and accommodations which have been already described, there are several others that are frequently necessary both for the convenience of the house and the feeding and management of different kinds of stock.

Those of the first kind are chiefly places for brewing, baking, washing, steaming roots for cattle, slaughtering animals in, &c. and for keeping rabbits, pigeons, bees, and other stock of a similar nature. The situation and construction of many of these are, however, not only so simple and well understood, but must so frequently depend on particular circumstances, that it is unnecessary to give detailed accounts of them.

Pigeon-Houses.—Where pigeons are bred for the purpose of deriving profit from them, the pigeon-house should not only be large and roomy, but be placed in such a situation that the pigeons may be fed with convenience, and without being disturbed by the different operations that are constantly going on about the farm-house. The form of the house is probably not a matter of much consequence, provided it be not made too deep in the inside; pi-

* Though this method may save much expense as well as room, it will certainly be disadvantageous in point of health; for it must be obvious to every one the least conversant with the nature of airs and respiration, that the air of such small close rooms must quickly be disoxygenated and rendered noxious by the breathing, perspiration, and heat, of so many persons; and that, unless seasonable supplies of fresh air be admitted, dangerous consequences may sometimes ensue.

geons disliking to have their nests low down. The floor should be closely laid, and the sides well plastered and white-washed over. The roof may be covered by any convenient and suitable material, but tiles and slates are by much the best: thatch, being warm in winter and cool in summer, may also afford a very good covering. The great objection to thatch for dove-cotes is, that the pigeons are apt to scratch it off; but when the ridge is secured by ridge-tiles, and very light hurdles are laid on each side of it, that inconvenience may be prevented. The whole must be made perfectly secure against the entrance of rats and other vermin. Where buildings of this sort are quite detached from the other offices, it is, perhaps, the best and cheapest method to erect them on pillars of brick or stone, or strong posts of wood, about six or seven feet high from the ground. In the latter case the upper parts of the house may likewise be principally composed of wood; and the under part will serve as a shed for various useful purposes: if a stable or cow-house, the better, as it will have a tendency to keep the pigeons warmer in winter, which is material to their breeding early in the spring, when they are of most value in the market The chief objection against wood cotes is, their being too cold in the winter and too hot in the summer months.

The apertures or openings for the entrance of the pigeons should always have a southern aspect, as they delight in a sunny situation; and they ought not to be too large: the common size is larger by much than is necessary. The number of holes must be regulated by the quantity of birds that are intended to be kept: it is better, however, to have too few than too many; as a great number of holes renders the dove-house cold, and in any case but few are made use of by the pigeons. Above these holes a piece of weather-boarding, sufficiently large for keeping off the wet, should constantly be fixed up. These boards are generally made so small that they do not keep off the wet effectually.

It is the general practice to make square holes of board for the pigeons to lay and breed in; but a neater method is, that of employing small wicker baskets open at the top for this purpose: these baskets may either be composed of finer or coarser materials, according to the inclination of the builder, or the expense he wishes to be at. Nests made in this way take up but little room, and are readily removed whenever it is necessary to clean them, especially if they be fixed up in a convenient manner.

Conveniences for preparing Cattle-Food.—On farms where a large stock is almost constantly either kept or occasionally fattened with different sorts of prepared vegetables, it becomes an object of great importance to have such accommodations as are proper and advantageous for performing the business.

Steam-Apparatus.—The practice of boiling what may be termed the artificial food of animals in steam, though extremely advantageous, not only in the saving of time and expense but in promoting the condition and feeding of them, has hitherto been, perhaps, too little attended to. Potatoes are the kind of food most generally prepared in this way; though other sorts may be rendered more fit for consumption by the same means, as the method of doing

it is perfectly simple and easy. A very simple and convenient apparatus for this purpose, where the practice is only conducted upon a small scale, consists in having a shallow iron kettle, of about twenty inches diameter and seven or eight inches deep, set over a furnace, and so fitted into brick-work or solid stone as to be perfectly close on every side. To the top of this kettle, a tub, having its bottom perforated with a number of small auger holes, is adapted, the kettle being previously half filled with water Potatoes must then be put into the cask, and the joining betwixt it and the kettle be well secured by a luting of clay. A close cover provided with a proper air-hole must then be put on, and the potatoes be steamed by making the water in the kettle boil. When sufficiently done, which may be known by removing the lid, they may be taken out by means of a proper shovel; or the cask may be turned and emptied into a barrow, or any other suitable convenience for receiving them, and a fresh quantity again introduced, if necessary.

At fig. 1. in plate LVIII. is the representation of a *steam-boiler* for potatoes or other roots, in which the parts A B C D in it and in fig. 2. are formed of brick or stone, being constructed in a cubical form, about three feet in every direction. *a* the door of furnace; *b* the ash-pit; *c* a shallow iron kettle, twenty inches in diameter and seven or eight inches in depth, placed over the furnace. B C a flat smooth stone covering the whole of the work, in the middle of which is a round hole cut out, to admit the iron kettle in a close manner. E a cask, the bottom of which is perforated with auger-holes and placed over the steam kettle when filled about half full with water. The cask is then filled with potatoes, and closely clayed all round to prevent the escape of steam, and the cover put on close. *d* a short thick plug, put slightly in a hole in cover, to afford air, or rendered moveable by a leathern hinge. F flue or vent, which may be built to a house or any other place.

The construction of this boiler is extremely plain and easy; but other apparatus for the same purpose may be readily contrived, so as to suit the most extensive farms. They might be so constructed, indeed, as that the steam from one kettle would be sufficient for steaming several casks of potatoes at the same time; and instead of such casks as these, large fixed boilers with moveable bottoms, so as to let out the potatoes upon proper vehicles being placed under them, might be employed. Casks suspended on cranes, with slides in their bottoms for emptying them by, would perhaps be a still more convenient contrivance. An useful aparatus of this sort is made by Mr. Cook.

But by much the most complete apparatus for washing and steaming potatoes for the purpose of feeding animals, is one constructed by John Christian Curwen, Esq. M. P.; and made use of by him in preparing these roots for the consumption of the horses employed in his extensive coal-works near Workington, in Cumberland, which answer as a substitute for hay; by which an immense saving is made. It is described, with a plate, in the Fourth Volume of Communications to the Board of Agriculture.

In the trials of Mr. Pierrepoint, the baking of potatoes has been found a more advantageous method of preparing them as food for

cattle, sheep, &c., than that of steaming, as they are supposed to be more nutritious and to possess a greater fattening property. An apparatus, or oven, with digesters for preparing them in this manner, has consequently been contrived, which consist of half a dozen common six-gallons digesters, for the purpose of containing the roots, introduced into an oven, the bottom of which is a *cast-iron* plate of three feet ten inches in length by two feet ten inches in width; under which is the fire, divided into three parts; the middle part or division of which is eighteen inches; the other two divisions are ten inches each; the remaining eight inches resting upon the brick-work. The heat is conducted half in one direction and half in the other, round the sides of the oven to the mouth, which is nearly eighteen inches square, and then over the top, uniting in the chimney, in which is fixed a damper. An iron rod is also necessary, with the segment of a circle at one end, for the purpose of pushing the digesters into the oven from the mouth, and a hook at the other end to draw them back with to the mouth when properly done. The first round, that is, the six digesters first put into the oven, take, it is said, about two hours in baking, supposing the fire not kindled before they are put in; and every other round after the first may be done in little more than an hour. It is further stated, that this process requires very little fuel, and not near the attention, or by any means the force of steaming, as the potatoes are done quicker or slower in proportion to the heat that is applied, without any of it being lost for want of greater force. It is necessary to rub the digesters occasionally on the insides with a little lard or dripping.

It is, in addition, suggested, that a cast-iron plate, five feet in length by two feet ten inches, instead of three feet ten inches by two feet ten inches as in the above, will hold eight digesters; and that adding a small fire in this manner, | 6 in. | | 7 in. long, 6 high. | | 6 in. | on each side the great fire-place, will accelerate the baking from fifteen to twenty minutes in every set of digesters, as well as save some fuel.

In regard to the consumption of fuel in this process, it is supposed that each set of digesters, containing about one hundred and sixty pounds of potatoes, when baked, will require a nineteenth part of a stacked cord of good wood, which for the whole costs about twelve shillings. The expense of the apparatus may be judged of from the following statement.

	cwt.	*qrs.*	*lbs.*	*£.*	*s.*	*d.*
Six six-gallon (wine measure) digesters, at 18s. each,	0	0	0	5	8	0
A cast-iron plate, 3 feet 10 inches by 2 feet 10 inches,	2	1	19	2	16	0
Two strong cast bearing bars - -	0	1	25	0	10	0
An extra double door and frame mounted with two doors at top and two at the bottom, with cranks to open together, and corkings,	0	3	24	4	14	6
				£. 13	8	6

The rest of the materials, which the inventor had by him, and the expense of setting, &c. are not taken into the calculation.

In constructing and managing these ovens, it should be kept in recollection, that the digesters must not be in contact with the fire; that these or other vessels even when placed on cast-iron must have legs, so that the bottoms of them are prevented from touching the iron plate; that where other vessels are used, they must have lids, steam-tight, with valves similar to those of the digesters; that it is not by slow simmering that the process is best performed; the quicker the roots are done in reason, the better; and lastly, that the external air must be excluded from them.

The roots are shown to be sufficiently done, by the escape of steam having a roasted-potatoe-smell a little before this happens, and by its being attended with a hissing noise as well as a sort of boiling commotion in the digesters, which is occasionally interrupted.

A representation of this sort of apparatus may be seen in the Fourth Volume of Communications to the Board of Agriculture.

On the mode of applying fuel in the first instance, and steam in the second, to culinary processes for cattle both on a large and small scale, Count Rumford's Philosophical Essays may be consulted with much advantage.

Corn-Mills.—These are of vast importance in particular situations, where the farms are extensive and of the grain kind.

They are of different kinds, according to the powers by which they are wrought and the manner in which they are applied, as *water*, *wind*, *steam*, *horse*, and *hand*-mills. It is remarked that in the state of society in which water corn-mills were first erected, they were undoubtedly considered as a blessing to the country; but there were, then, no *flour-manufactories;* and it was of course more convenient for the inhabitants to carry their corn to the neighbouring mill, than grind it at home, by means of hand labour, in a less effectual manner. In this way it was supposed the privileges and immunities of manorial mills were established, as well as the arbitrary regulation of *thirlage*, a custom which is still continued in some parts of Scotland, notwithstanding its being extremely absurd and impolitic, in preventing the growth of grain. And though some remains of *grist*-mills may still be traced in particular situations, they are conceived to be now fast going into disuse, as even the labouring part of the community purchase *flour* in the place of *corn*, which is apprehended to be an eligible practice, whether considered in a public or private point of view; as they can get a sort which is perfectly suited to their circumstances, and know the quantity and quality of what they procure; of which they have no certainty in the other case, from the well-known unprincipled conduct of grist-millers; and besides, every particle is preserved in the flour-mill without waste. And another valuable property of modern flour-manufactories is, their not requiring the different brooks and rivulets of the kingdom to work them; the waters of which may be converted to other important purposes. It is the practice in Norfolk and many other districts to manufacture a large portion

of the wheat crops into flour, by means of wind-mills. And the success of modern invention has been such, that at present neither the power of wind or water is necessary for the purpose, the *steam-engine* affording a more constant and regular power for effecting the business.

Water-mills are not, however, to be altogether condemned, as that sort which is denominated from its nature the *tide*-mill is highly deserving of encouragement, there being a variety of situations in the different creeks, bays, and inlets of the island, in which they may be established with great advantage, to the proprietors as well as to the community, without the least injury being sustained in respect to the agricultural produce or landed property of the kingdom;—though it is conceived that the number of river-mills that are now in existence are unnecessary to the present state of society.

In some more remote situations, it is even conceived that grist-mills may still be found beneficial; but that, from the number of flour-mills that are now dispersed over the different parts of the country, the great facility of land and water carriage, and the vast injury that is occasioned by them in an agricultural point of view, it is conceived that they should be reduced in number as much as local circumstances will permit. The principal disadvantages that attend river-mills are those of their damming up the waters in such a manner as often to flood the lands above them during the summer season, and their being collected in a body so as to remain in a slow moving or stagnant state, the adjoining lands being thereby so surcharged with water as to produce little more than coarse aquatic plants, or be converted into the state of morass. They are also highly prejudicial to fisheries, especially those of the salmon kind. But where such streams possess properties of the fertilizing kind, these are but trifling considerations, as the waters for the purposes of agriculture are of ten times the value they are of for those of turning mills. Besides, they are unprofitable parts of estates, as the expense of repairs, with the timber and attention which they demand, is in many cases more than the rent which they afford.

As, however, it may sometimes be necessary to erect this sort of machinery, it may not be improper to observe that there are four different sorts of mills of the water kind, as the balance, over-shot, breast, and under-shot, from the differences in the modes of applying the moving power. In the first, the water is conveyed in a sort of spout, usually termed the mill-trough, above the wheel, and falls into the bucket, about one foot before the centre, where it operates by means of its gravity on nearly one-half of the circumference of the wheel. The second sort is nearly the same as the first, only in this the water is conveyed over the top of the wheel and discharged into the bucket behind the centre of it, where it operates chiefly by its gravity; as the impulse can only be small, from the fall upon the upper part of the wheel not being considerable, as that would have the effect of dashing the water out of the bucket, and of course produce a loss of a part of its power on the wheel. In the third sort the water falls down upon the wheel near-

ly at right angles to the bucket, and of course acts both by impulse and gravity on one-fourth part of the circumference of the wheel. The last sort of mill is wholly driven by impulse, or the force of the current of water running underneath it, and consequently requires a much larger supply of water than any of the others.

Much improvement has lately been made by Mr. Beatson on horizontal mills, by constructing and disposing those surfaces upon which the wind, water, air, or any other fluid, are designed to operate, in such a peculiar manner, as that by alternately opposing a resisting and non-resisting surface, the whole force or impulse may operate in a direct manner upon the resisting side of the wheel vane or sail, in proportion to its extent, and, when the non-resisting side is returning against these powers, the machine being so contrived that there is very little resistance, however large the surface. When applied to horizontal wind-mills, their power, even with the small quantity of sail, or acting surface, may be increased or diminished at pleasure.

Various descriptions and representations of different sorts of corn water-mills, as well as other kinds, with the most improved methods of constructing them, may be seen in Gray's Experienced Mill-wright.

In many cases, where only small supplies of flour are wanted at a time, small mills wrought by the hand may be convenient and useful. Many different mills have within these few years been constructed in this view.

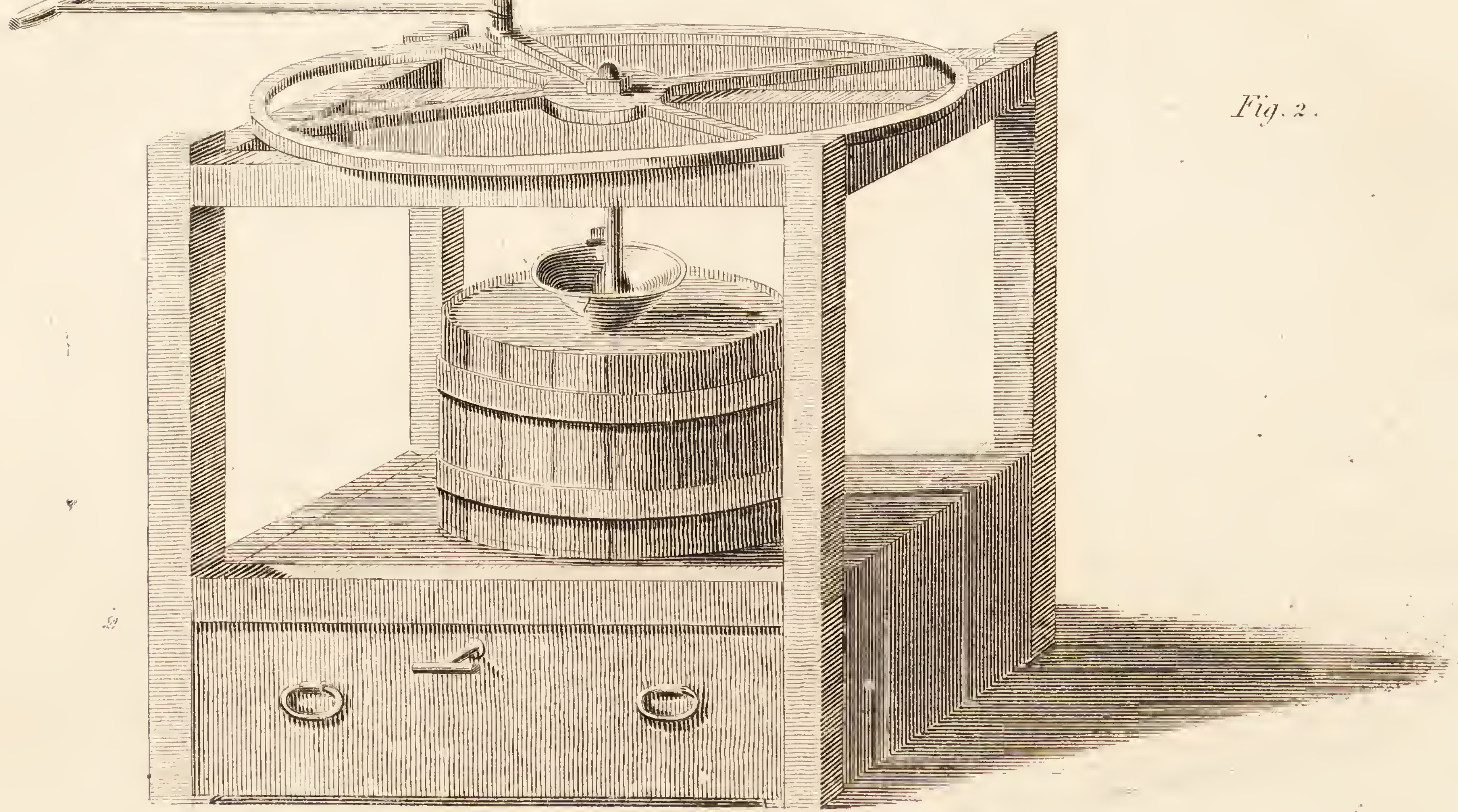
In plate LIX. is the representation of a horizontal hand corn-mill invented by Mr. Wright. The frame is three feet square and three and a half in height. The stones are eighteen inches in diameter, and inclosed in the tub, supported by two cross bearers, under which is a lever, having an iron pin or pivot, which runs through the centre of the bed-stone into a socket in the bridge of the upper stone or runner, to which is attached the shaft and spindle, running through the eye of the runner and hopper, and supporting the fly wheel and crank. A round piece of wood fastened on the shaft serves as a feeder; above is a screw to regulate the feed according as turned. On the side of the tub is a thumb-screw fixed to the lever underneath, which regulates the stones according as turned. The shaft runs through the crown tree or cross bar at the top of the frame, on which is the horizontal fly wheel and crank; to which are attached one or two handles, by which the mill is put in motion. Under the stones is a drawer, in which are placed three sieves of different finenesses; one for taking away broad bran, another for the coarse pollard, and the third for stopping the fine pollard, and letting the flour pass into the drawer, which is effected by a sort of iron fork running through a hole in front of the drawer, and fixing on one of the sieves.

The price of the mill is sixteen guineas, and one guinea for the set of sieves.

Corn-Chests.—It is equally convenient and œconomical for the stable of even the common farmer to be provided with accommodations of this sort, much time as well as waste of corn being

WRIGHT'S HORIZONTAL HAND MILL. PL. LIX. 2

Fig. 2.



saved by it. Besides, many other substances can by such means be kept ready mixed with the corn; such, for instance, as cut straw, split beans, and several other articles that may be advantageously employed in the feeding of horses A common bin or tub may, in some cases, be sufficient for the purpose; but on large farms, and where there is convenience, it is by much the best to have them constructed on the principle of the granary, which has been already described. Where this plan is adopted, the form should be cubical, the bottom being made somewhat in the manner of a hopper, with a slider so contrived as that it may stand about eighteen inches from the floor, by which means sufficient room will be given for taking out the provender. The spouts may be fixed from side to side with great ease and facility, and the air-holes be well secured by a grating of iron wire. If it should be thought necessary, the slide may be fastened by means of a small lock and key.

At fig. 13. in plate LV. is shown a *stable corn-bin* of this kind: *a* the wall of stable; *b* the floor of room; *c* corn-bin with air-spouts; *d* a spout below the bin in stable; *e* a plate iron slider at its bottom with lock if necessary; *f* another slider to regulate the feed between it and *e*, the feeds being this way easily taken out.

Corn-Stands.—Where the very beneficial and advantageous custom of stacking grain is practised, it will be necessary to have proper stands or staddles provided for securing the corn, not only against damp and moisture, but against the destructive waste of rats and mice.

The mode of constructing these stands varies very considerably in different situations and districts. In some places they are formed merely by placing two or three pieces of large timber length-ways, and then putting smaller ones cross-ways upon them. This is, however, a plan by no means to be followed, as it provides no security for the bottom of the stack. In other cases a strong framing of good timber is put upon posts of wood, or, what is better, of stone, about two feet high, provided with caps, on which it rests in a very solid and secure manner.

But the most secure method is to have these sort of stands walled, and well guarded by good copings. Corn-stands, constructed in this way, have lately been erected on the farms of His Grace the Duke of Bedford, at Woburn-Abbey, whose extensive knowledge of the science of agriculture seems not less than his zeal in promoting its improvement. The foundations in making these stands being sunk a considerable depth into the ground, and the bottoms well laid, vermin cannot get to the grain of the stacks by working under them; and the upper part is rendered safe by a projecting coping of stone or wood. Substances should not, however, be suffered to rest against them, or the loose corn to hang down during the time of building the stacks. In this way stacks of the parallelogramical form may be built to any size; but for small stacks, especially where wood is employed, the octagonal form of stand should rather be preferred to the circular one, as the copings may be cut with less waste, and from smaller timber; and it is just as easy to build a circular stack on an octagonal stand as on a circular one.

Where stone can be easily procured, it is unquestionably the most proper material for the bottom; but brick, if properly made for the purpose, answers very well, especially if proper care be taken in the laying of it. Slate, where it can be had at a reasonable expense, will be a very good substance for the same purpose. Flag-stones would likewise answer extremely well; but neither slates nor flag-stones are necessary, if the foundation be laid sufficiently deep to prevent the vermin burrowing under it.

Stands of this kind were made use of by the late Mr. Bakewell with much advantage; and other farmers, in the same district, probably employed them before him.

At fig. 1. in plate LX. is shown an elevation of a *stack* on its *stand.* Fig. 2. the plan of a round stand for corn-stacks. Fig. 3. a section of the same stand. Fig. 4. is a plan of a stand for an octagon stack.

Stacks are likewise sometimes built upon stands, on wheels moving in circular iron rail-ways, so contrived that three or four horses may in most cases, with moderate-sized stacks, draw them to the thrashing machine. This method of constructing them is highly advantageous, in saving the expense of carting or otherwise conveying them to such machine, besides being capable of being performed at any time, without waiting for fine weather. It is observed by Mr. Young, that as the expense in this way is very trifling, it can hardly be supposed that any one will go to that of capped stone standings. The circular form of the rail-ways for bringing the stacks to the machine, is, he says, necessary, as being that only which admits a choice of any particular stack to thrash, without waiting for the whole or a great number of the others being previously removed. In other cases, a straight line leading to and past the machine may answer, though inferior in some respect. This excellent contrivance is represented in different plates in the Thirty-third Volume of the Annals of Agriculture.

Stacking-Stages.—Where stacks are built to considerable heights, whether they be of the corn or hay kinds, stages are found highly useful in finishing the upper parts of them, rendering the work much more easy and convenient to the men, as well as more expeditious in being performed. Stages of this nature have been made on many different plans, but the more simple the better. It is necessary to attend to the circumstance of their being so put together, that the different parts may be unscrewed and taken to pieces; as, when this is not the case, they must constantly remain out of doors in the wet, and of course be soon destroyed.

At fig. 5. in plate LX. is represented the frame of a *moveable stage* for this purpose: *i i*, iron hooks. Fig. 6. the stage, to be fixed, by means of the pins *l l*, into the holes of the frame. Chains are fastened on the plates *m m*, and from thence put over the hooks *i i*. Fig. 7. is a stack with a moveable stage erected against it.

Bee-Stands.—Although bees have hitherto seldom been much attended to by farmers as objects of profit, they certainly ought not to be overlooked in the system of rural œconomy. But in order to

PL. LX. 8°.

STACKING APPARATUS.

Fig. 1.

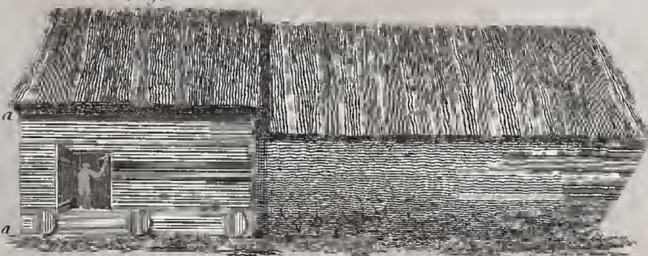


Fig. 5.

Fig. 2.

Fig. 4.

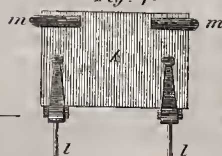


Fig. 3.

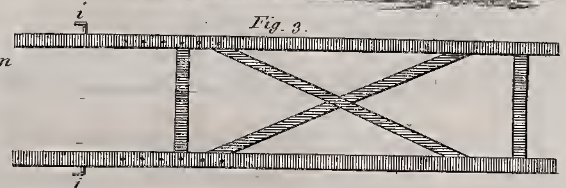


Fig. 6.

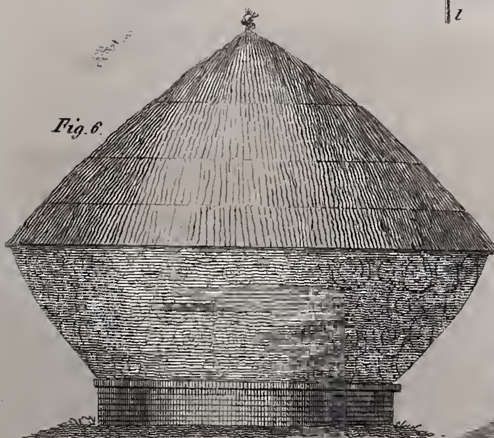


Fig. 7.

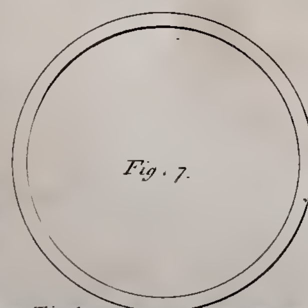


Fig. 9.

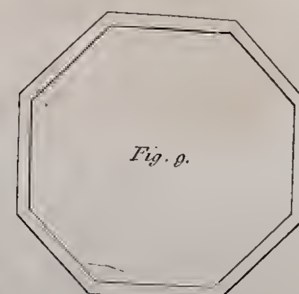
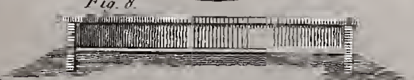


Fig. 8.



turn their industry to advantage, the farm must be provided with proper and sufficient accommodations for them. These are, perhaps, the most convenient and least expensive when constructed in the form and manner of slight sheds or stands, and made of good seasoned wood, so framed that the fore part of the shed or stand may be about six or seven feet high, and the hind part five or six. The top, and also the ends and back, must be well covered with strong boards. The inside should likewise have a lining of very thin deal boards, and be furnished with strong shelves, so proportioned as to suit the number of hives, boxes, or glasses, that are to be placed in them. To the front, which is open, thin wooden shades should be so fixed and contrived, that they may be raised and depressed at pleasure, in order to protect the bees both from the too powerful effects of the sun and the rain.

The bee-house should always be placed in such a situation as not to be much exposed to winds, as these animals are liable to be very much disturbed by them. It should likewise, if possible, be near to water, and plenty of early-blowing flowers, such as flower-gardens, turnip, mustard, and bean-fields, &c.

Situation and Arrangement of Farm-Houses and Offices.—I shall now proceed to show the situations and arrangements of farm-buildings, which promise the most advantage in respect to the œconomy of human labour, the saving of expense in the construction, and the prevention of waste in the articles which they contain.

Where a choice of situation can be had for the farm-house and offices, it should certainly be as near as possible to the centre of the farm, and rather elevated; by which means the various kinds of produce, as well as the manure of the farm-yard, may be conveyed to their proper destinations with the greatest facility and dispatch: it should likewise be dry, well supplied with water, and the approach easy and convenient.

It is at present mostly conceived that the different offices of the farm should have such an arrangement as is necessary to form a regular figure, inclosing a sort of area or yard as a fold for loose cattle, or, where the stalling of the animals is in use, as a receptacle for the dung. And for this purpose some think that the three most exposed sides of a square should always, where it is possible, be chosen for the situation of such offices; that to the south being left free and open for the admission of sun and air.

Mr. Marshall, however, thinks that square yards possess many defects. "The angles are, he supposes, too sharp, and the corners of the yards too deep; and the road-ways necessary to be carried round them, in order to afford convenient passages between the different buildings thereby greatly lengthened. Besides, he does not think that the square form affords so good a view of the whole of the yards and their surrounding buildings from the dwelling-houses placed on the sides of them, as those of the circular or oval kinds. Buildings are however always erected more cheaply on straight lines than those of the circular or oval nature. It is likewise suggested by the same writer that the octagonal form may be advantageous in

many respects; in one of which, formed on this plan, the dwelling-house was placed on one side, and the entrance gateway and granary opposite, the other six sides being occupied by stables and cattle-sheds, having a broad way dipping gently from the buildings, surrounding a wide shallow dung-dish which took up the rest of the space or area of the yard. Mr. Young also seems to prefer the circular plan, with the circle of cattle and team-sheds opening on the outside for the entrance of the animals, the dung being voided into a circular repository that surrounds all the sheds, which he considers as much more useful and convenient than where they open within the circle.

The above circumstances, however important they may be, seem to have been too little regarded in the building of farm-houses and offices in general; as we frequently find them occupying not only the worst but the most inconvenient situations that the farms afforded. Where the form of the ground and other circumstances are favourable, and readily admit of pursuing any design, the most pleasing, though by no means the best, situation for the farm-house is that of the middle of a regular front. It is always much better to have it at a small distance from the offices and the farm-yard; from fifteen to twenty feet at each end will, in general, be sufficient. Where uniformity is particularly attended to, these spaces may be occupied by naked walls, or, what is better, a sort of lean to sheds may be formed from them for various useful purposes. It is also frequently necessary, in the designs of farm-houses and other buildings, that the daily transactions of servants and labourers about such houses and offices should at once be overlooked and examined. With this view, the common sitting or work-room should have such a position as that the business of the house may be readily seen from some one part of it, while that of the farm-yard and out-buildings may be attended to from another.

In disposing and connecting the different buildings and offices, much attention is likewise required, in order that they may be convenient and suitable to the particular business of the farm. The nature of the situation, and the state of the ground, will for the most part afford the best directions for placing the drains and other conveniences for taking off the superabundant moisture, as well as the proper place for depositing the dung and collecting the urine into; and these again will, in a great measure, show where the stables, cow-houses, feeding-sheds, root-houses, and other offices relating to them, should be situated. The barn should obviously be at no great distance from them; adjoining to which, on the sides, should be the barn-yards and straw-sheds, the two ends forming the straw-yards and stack-yards. In every case, perhaps, the stables should be as much as possible detached from the other buildings, in order that they may be the more secure from fire. The granary, where necessary, should always be near the barn, or even in it: if a thrashing-machine be erected, it may be very conveniently placed over it. The dairy should be distributed in such a way that it may be equally convenient to the dwelling-house and the cow-houses and yards, and at the same time be as little as possible

exposed to either excessive heat or cold. It is advised by Mr. Young, that "the entrance into the milk-room should be through the scalding-house, and that the copper for heating water, &c. should be in a shed without the scalding-house: that the heat may be as far as possible from the milk, the boiling water should pass by a cock, in the bottom of the copper, through a trough or pipe across the scalding-house (another cock being there in the pipe for washing smaller implements) through the wall into the milk-leads, that whenever the dairy is free from milk, &c. or without being free in winter, the water may pass at once through the whole system of leads or trays, and be kept standing at pleasure in any of them, which is the most effectual method of scalding; and, having made the tour of all, may pass out to a drain." And it is added, that "the immediate passage of the water through the wall of the dairy should be in a trough large enough to receive securely a pail of milk emptied by it, that all from the cows may run at once through a hair-sieve in this trough into as many trays as are requisite to receive it. This prevents all ingress to the dairy by dirty men and boys, who may bring pails of milk to it." The dairy may have a circular form, and be provided with a fountain of water to play in it in the summer, so as to fall in a circular *jet*, having a clean gutter to convey it away. The hog-sties, as well as the poultry-yards should, in order to avoid labour, be near to the dairy, yet not so very near as to incommode it.

The distribution of the inferior sort of buildings and conveniences must be regulated by the particular circumstances of the situations; but the principal and leading consideration in directing every building, should be the business for which they are destined, and the saving of time, labour, and trouble, in the performance of that business, by giving them the most suitable connection and distribution.

The nature and arrangement of the houses and buildings proper for the accommodations of farmers being thus explained, we may offer a few observations on the expense at which they may be constructed. This is, however, a point on which it is difficult to speak with much precision, as various circumstances, in respect to the situation and facility of procuring materials, must obviously make considerable differences in all such estimates: besides, the prices of materials, as well as labour, have considerable local variation; but, as far as any general rule will apply on such subjects, it is probable that, provided the farm be not under sixty or seventy pounds a-year, one, or, at furthest, two year's rent, will be fully adequate to the building of every office, independent of the house which is required for such farms; and on all farms of from three to four hundred pounds a-year, one year's rent, or even much less in particular cases will be sufficient for building the dwelling-houses: and probably, on farms of any extent, five hundred pounds is an ample allowance for the dwelling-houses, and one thousand or twelve hundred for the respective offices. Various useful and convenient plans and estimates of farm-houses and offices have been proposed, for farms of

different kinds, by Mr. Crocker, in a paper in the First Volume of Communications to the Board of Agriculture. For those which are wholly of the dairy kind, and from 60 to 100 pounds per annum, his estimate is 265*l.* 1*s.* 0*d.*; but for one from 100 to 200 pounds per annum, it is 357*l.* 17*s.* 6*d.*

At fig. 1. in plate LXI. are exhibited the plan and elevation of a farm-house, of the dairy kind, on a middling scale. Fig. 2. shows the ground plan. And fig. 3. explains the nature and aarangement of the different buildings for the use of the cattle, &c.

Those that are entirely employed in the growth of grain requiring more extent of buildings, the estimates, of course, stand considerably higher; for one of from 100 to 200 pounds per annum, it is 569*l.* 13*s.* 8*d.*; and for one of from 200 to 300 pounds per annum, it is stated to be 737*l.* 4*s.* 8*d.*

At fig. 4. in the same plate, is a representation of the plan and elevation of a corn farm-house on a middle scale. Fig. 5. is the ground-plan of the same. And fig. 6. shows the distribution of the several out-buildings that may be requisite for the same.

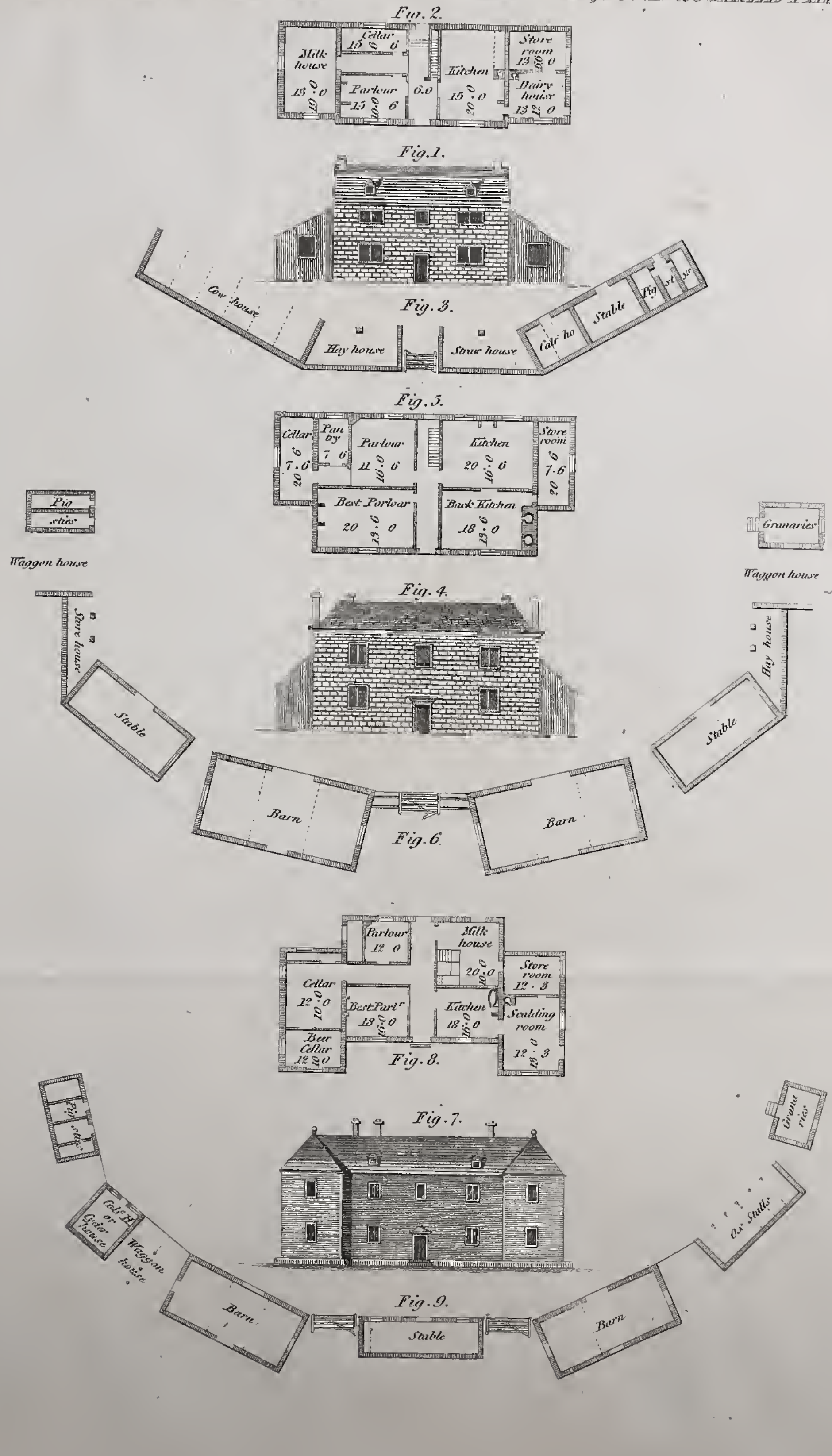
There are others which partake both of the nature of the corn and the dairy-farm, in which a variety of buildings must of course be required: the estimates for these are consequently still higher: for a corn and dairy-farm of from 200 to 300 pounds per annum, 595*l.* 1*s.* 6*d.* is supposed little enough; and of from 300 to 400 pounds per annum, 766*l.* 8*s.* 0*d.*

At fig. 7. are shown the plan and elevation of a farm-house of this kind on a middle scale. Fig. 8. is the ground-plan. And fig. 9. shows the situation and distribution of the several out-buildings.

In the constructing of new farm-houses and buildings great savings may always be made where there are old erections, by the use of different kinds of old materials which are produced from them.

As all buildings of this sort should be made as durable and lasting as possible, the materials that are employed should always be of the best kinds. It is remarked by an intelligent practical writer, that "tiles or slate are the best coverings for houses; but barns and stables should be thatched, because workmen are always careless in laying corn and hay into them, and generally push the tiles off with their prongs: and besides, these buildings, when empty, collect a great deal of wind, which is apt to dislodge them, unless they are pointed in the inside; which increases the expense considerably, and is never lasting. Reed is the best of all coverings for barns, stables, cart-houses, &c. There is, he says, a sort of reed which grows in fens, marshes, and wet lands, so excellent for this use, that a moderate coat, if it be well laid on, will endure at least half a century, with very little expense of reparation: and it is a fact beyond contradiction, that the timber used in roofing will last thirty years longer when covered with reed than it will when covered with tiles. The next best covering to this is, he thinks, the *Somersetshire reed*; which is nothing more than the strongest wheat-straw which can be met with, combed clean from weeds, having the ears of the corn cut off, instead of being thrashed, and so laid on upon the building

ARRANGEMENT OF FARM OFFICES FOR DAIRY, CORN & MIXED FARMS.



in whole pipes, unbruised by the flail. This latter reed may be had in any other county, as well as *Somersetshire*, in sufficient quantity; and it is absurd, in the last degree, he says, to make use of straw for thatching in any other way, because the difference of expense in the preparation is a mere trifle, compared with the difference of duration between the *Somersetshire-thatch* and that of other counties. The common, injudicious, slovenly practice of beating the straw to pieces with the flail, and then laying it on with some of the seeds and many weeds in it, causes it very often to grow quite green, after it is laid upon the building; and, being bruised in all parts, to collect and retain the wet much more than it would if the straw were whole, and consequently to become quite rotten in a few years. Where straw is designed for thatching, it is a good way to cut the corn rather earlier than ordinary.

Where tiles are employed, they should be well made, and kept well pointed with lime both on the inside and the out, as often as may be necessary; for without attention in these respects they form a very insufficient roofing for houses, from their readily admitting rain and snow.

In regard to the timber most proper for building with, the author just mentioned says, " that he knows of none that is to be preferred to Spanish chesnut, where it can be had, because it is very pleasant to work, and as durable as oak, though it seldom bears the price of it. In maritime counties, where oak sells well, and deals are tolerably cheap, it is best to dispose of the one, and buy the other; because oak is generally cut to waste in most repairs, and deals may be bought of any scantling that may be required.

" In all paling, battoning, and other fences about the home-stall, nothing is, he thinks, more useful than pollards; and they should always be made use of on such occasions, because they are generally the produce of the farm, of little value, and save better timber. Sometimes they are useful in sheds, and small buildings, for cattle. Bricks are a very considerable object, and great care should be taken in getting them of a good quality. Upon most estates of any considerable size, brick, earth, or clay, may be met with; and, where this is the case, they may be always made, and burnt in clamps, for one-third less than they can be bought at the kilns, and equally good in quality. He has had a great number burnt in this manner, from eleven to fourteen shillings a thousand, in different counties. The medium price is twelve shillings a thousand where fuel is reasonable. Besides the difference in price, there is generally a great saving in carriage when gentlemen burn their own bricks. It is observed that the price of brick-burning in Norfolk is at this time from a guinea to twenty-five shillings per thousand, the brick-burner finding fuel. Perhaps it is as well for the proprietor to provide fuel for himself; as, when provided by the man who takes the job, there is great danger that the bricks will be insufficiently burnt; which is a fraud that cannot be discovered till it is too late to apply a remedy. No material in building requires greater inspection than mortar, in which masons are apt to be deficient. Two things are to be attend-

ed to; the quality of the different articles, and the manner of mixing them."

It has been well observed by another practical writer, who seems to have examined the systems of farming carried on in different districts with considerable attention, that though, in general, "the size of the farm, and the system of husbandry adopted, must regulate the extent as well as the sort of buildings to be erected; yet, in order to introduce and carry on spirited agriculture, sufficient accommodation in regard to houses is necessary. Accordingly he has found, that in every part where the proprietors are negligent in furnishing their tenants with proper farm-buildings, or granting a reasonable allowance for that purpose, agriculture, as well as all the other branches of husbandry, remains in a languishing state; but that, on the contrary, wherever substantial and commodious farm-offices have been built, whether at the expense of the proprietor or tenant, improvements in agriculture have always succeeded."

This not only shows the great advantage of having proper buildings, in so far as they respect the management of the farm, but that they have likewise considerable influence in promoting the improvements of husbandry.

SECTION III.

Farm-Cottages.

HOWEVER much the building and providing of suitable accommodations for farming labourers may have been neglected or unattended to, it is evidently a subject of considerable interest to agriculture, and upon which, perhaps, much of its success and improvement depends. It has been well obsereed by an able writer, that without hands for the purpose of cultivation, estates are of no value; consequently, the farming labourer is one of the most important members of society: without his assistance, the best and most fruitful soil is not worth possessing: his condition should, therefore, if it were only out of good policy, be rendered more easy and comfortable. If no other motive should operate in the promotion of this purpose, the interest of the farmer and land proprietor of every description evidently, he thinks, demands it.

The advantages of letting persons of this class comfortable cottages with gardens, and small plots of grass land adjoining them, as far as it respects themselves, have lately been well explained by the judicious inquiries of several noble authors*. And that such a plan would be equally, if not more, beneficial to the farmer, there can be little doubt. For it is obvious, that though he may have a certain number of labouring people constantly about him, they will

* Earl of Winchelsea, Lord Brownlow, &c. in Communications to the Board of Agriculture, vol. i.

not be able, on every occasion, and in every place, to perform all the business that is necessary on his farm. He must, therefore, either be under the necessity of keeping more servants than are absolutely requisite, at great expense, or he must have recourse to the aid of the cottage labourer. This clearly proves the importance of cottages being connected with farms. This is, however, far from being the only point of view in which it is important; it is mostly from amongst this class of men that the best and most expert labourers in the business of husbandry are procured: being, in general, inured from their infancy to such labours, and accustomed to perform the different operations of farming, they are enabled to manage the practical part of agriculture with much ease and readiness; which is far from being the case with the common labourer, who, for the most part, has been brought up to some other occupation or employment. Besides, on such farms as are at some distance from towns and villages, these accommodations for labourers seem indispensably necessary, as without them much time must, of course, be lost in going backwards and forwards to their different meals, and the places in which they lodge; and from the unavoidable fatigue that attends this mode, they are little disposed to procure work at a distance, if they can possibly get it at the places where they reside; which in many situations often reduces the farmer to much inconvenience, if not actual loss. Where, therefore, the system can be introduced with convenience, and a mutual interest be established between the farmer and the labourer, it will be to the advantage of the former to have as many cottages on his farm as possible; and under some circumstances, as in case of long lease, it may even be advantageous for him to build them, or at least assist the proprietor in doing it, by the conveyance of materials, and other such means as are in his power.

In this way, the condition of the labourers in agriculture would be considerably improved; their means of living be rendered more certain and easy; their habits more regular and industrious; and their dispositions, in general, probably more favourable for the business of cultivation.

But, in order the more readily and effectually to promote and accomplish a matter of so much consequence to agriculture, every obstacle should be removed out of the way which has the least tendency to retard the erection of such buildings; whether arising from old acts of parliament made under very different circumstances from the present, or parochial and other regulations of a more local nature.

It has been a remark of great antiquity, that nations are rich in proportion to their population; "and so," an able writer on the subject of cottages observes, "it is in a great measure with an estate or a farm; for, the more numerous its inhabitants, the more easily will it be cultivated and improved. The erection of cottages is, therefore," says he, "an object of great importance to the farmer as well as to the proprietor: but it is necessary, for the mutual advantage of both parties, that the landlord and his cottagers should be on the best terms: that he should regard them as part of his own

family, and that they should look up to him as their best and surest friend and protector. Every cottager should, therefore, consider, that in promoting the interests of his landlord, whether proprietor or tenant of the farm, he is at the same time promoting his own; for a landlord has it much in his power to serve and oblige his cottagers in various ways, as they themselves must be sensible of.

With a view to render the building of habitations for the labourers in husbandry, not only more agreeable, but more advantageous to the different parties, it would, perhaps, in many cases, be useful to have suitable conditions stipulated between them, by which the landholder should be secured for the labour of his tenant, when necessary, upon fair and equitable terms, while the labourer is made certain of his residence, on the due performance of them. In regard to payment of rent, on some occasions, it would, likewise, be extremely proper and convenient to have such regulations as would secure its discharge in the most easy and least oppressive manner. By adopting some such plan as this, many disagreeable disputes, and much uneasiness, would frequently be prevented, and at the same time the cottager be enabled to perform his engagements with greater exactness, and far more comfort to himself.

That cottages, wherever it can possibly be done, ought constantly to have some portions of land annexed to them, seems generally allowed; but the mode of attaching it, and the quantity which is requisite in different cases, are matters of considerable difficulty, and which must, probably, depend on various local circumstances; such as the abundance or scarcity of land, the manner in which it is cultivated, and the dispositions of the occupiers. In every situation, perhaps, a sufficient quantity for the growing of proper vegetables for the cottager and his family may be spared, as for this purpose not more than twenty or thirty perches of ground will be required. It is, however, notwithstanding this, well observed by the Earl of Winchelsea, in the valuable paper which we have already quoted, that the best situation for a labourer is that of his holding a sufficient quantity of grass inclosed land for the keeping of one or more cows winter and summer, with a garden contiguous to the house; as in this case all the business is done by his wife, except that of making hay, and he is not taken off from his labour. Various important advantages have been found to result from this system, both to the cottagers, the proprietors of the land, the farmers, and the nation at large, in the experience of Mr. Babington and Mr. Thompson, as may be seen in their very interesting papers on the subject in the Fourth Volume of Communications to the Board of Agriculture. This kind of allotment has, however, hitherto been chiefly made where grass land is abundant; but on the plan proposed by Sir John Sinclair, in the same work, it is shown that it may be done in other cases, as where the ground is under the plough, with equal success and benefit.

The next situation in point of advantage the noble Earl conceives to be that in which the cottager has a summer pasture for his cow, and a portion of arable land upon which the winter provisions are grown. In this case it is, however, obvious that too much of the

labourer's time must generally be taken up by the management of his arable ground. Where, indeed, a part is sown with artificial grasses, it may not be so employed to any hurtful degree. On his lordship's estates this plan is found to answer very well. It is evident that this mode of distribution must be very narrow and confined in its operation, as it can only be had recourse to in cases where there is a mixture of arable and pasture grounds.

The third situation, in respect to the benefit of the farming labourer, is that in which he has a right of common for the summer keep of his cow, and a meadow or arable land; or a meadow in common for the providing of winter food.

This, his lordship conceives, would be nearly equal to the two former, were it not that commons are so frequently overstocked as to render the summer keep extremely bad: this is of course a great loss; and if the meadow be in common too, the matter is still worse He further remarks, that "it is certain that upon an inclosure, if the owners choose it, the labourers who keep cows may be placed in a much better situation than they were, inasmuch as inclosed land is more valuable to occupiers of every description than commons and open fields. Garden ground may also be allotted to them and others, which cannot be done while the land remains uninclosed. I am persuaded," continues he, "that where these things are attended to, very few objections to an inclosure will arise on the part of the labourers, and that the land owners will have the satisfaction of benefiting the poor, and at the same time of making their own property more valuable, by adopting, what, in all probability, will be the means of keeping down the poors' rate."

In these situations, gardens are always supposed to be near the house; but where they have more, or where the ground lies at some distance from them, the advantages cannot by any means be so great.

The fourth situation is that in which the labourer has a right of common, and a garden. This is highly beneficial, his lordship supposes, as geese and pigs may be kept upon common pasture, and the latter be fed by means of the garden stuff and a small quantity of other food which can be easily procured by the cottager.

The fifth case is that in which the labourer has a right of common, but without a garden. This, he thinks, is obviously of little utility to him, unless in situations where fuel can be procured from it; in which case it becomes extremely valuable, and the loss of which cannot be easily repaired.

The sixth is that situation in which the labourer has some arable ground, but without any summer pasturage for his cow. This his lordship considers as of little use; "for," says he, "though he may cultivate part of the land as a garden, the continued labour it would require to stall-feed a cow winter and summer, and the quantity of land he must till, would occupy so much of his time, that the *take* would, upon the whole, be injurious to him, even supposing the land inclosed, and contiguous to his house; and if at a distance, or not inclosed, the disadvantage would be still greater.

The seventh situation of the cottage labourer is that in which he

has merely a garden adjoining his habitation. This his lordship considers as the best thing that can be done for labourers in arable countries; as lands cultivated in this way afford a much greater quantity of food for man, than when managed in any other manner. Besides, the greatest part of the work is done at such times as the labourer and his family can conveniently spare from their more particular employments.

The last, and by much the worst, situation is that in which the labourer has no land whatever. Under this circumstance he cannot, his lordship thinks, be so comfortable to himself, or have the means of making his children acquainted with that kind of labour and knowledge which is essentially necessary for them. "When a labourer is possessed of cattle," says the able author of the paper we have beforementioned, "his children are taught early in life the necessity of taking care of them, and acquire some knowledge of their treatment; and if he has a garden, they learn to dig and weed, and their time is employed in useful industry; by which means they are more likely to acquire honest and industrious habits, than those who are bred up in the poverty and laziness we too often see; for I believe," continues he, "it is a certain fact, that extreme poverty begets idleness."

These interesting observations clearly show, that on such grounds there cannot be any doubt of the advantages of farming labourers possessing small portions of land, or at least gardens. It is a system which tends not only to benefit them, but which, at the same time, must greatly contribute to the interest of the owners of land, and the community in general. Such a plan cannot, indeed, from various local causes, be generally introduced; but it may be rendered much more common and extensive than it is at present, since the narrow, confined, and illiberal notions, which have so long retarded its execution, have now been fully shown to be erroneous and ill founded. It is well observed by the noble author we have so frequently mentioned, that, "in countries where it has never been the custom for labourers to keep cows, it would be very difficult to introduce it; but where no gardens have been annexed to the cottages, it is sufficient to give the ground, and the labourer is sure to know what to do with it, and will reap an immediate benefit from it."

The advantages of the plan of letting cottagers have small portions of land, for the above purposes, where the ground is chiefly under the plough, are, in the opinion of Sir John Sinclair, the following: First, the complete cultivation of the land, so as to render it the most productive possible; secondly, the promoting the benefit of a numerous class of individuals in the most effectual manner, by extending a system found highly advantageous in the grazing districts over the whole kingdom; and thirdly, as being the means of removing a principal obstacle to the improvement of the country, by its taking away the popular objection to the inclosing of waste lands and commons, that of cottagers being enabled to keep cows, from their rights, on them while they remain uninclosed.

A plan of this sort of cottage-farm, and the modes of cropping it, is given in the following tabular view.

PLAN OF A COTTAGE-FARM.

Cottage.	Orchard or Perpetual Pasture.	Pond.
Lot A. 3 Roods. 1 Year. {2 Roods potatoes. 1 Rood turnips.}		Lot B. 3 Roods. 1 Year. {2 Roods winter tares. 1 Rood spring tares.}
Lot C. 3 Roods. 1 Year. Barley, wheat, or oats.		Lot D. 3 Roods. 1 Year. Clover and rye-grass.

ROTATION OF CROPS FOR FOUR YEARS.

Year.	Lot A.	Lot B.	Lot C.	Lot D.
1	Potatoes and turnips.	Winter and spring tares.	Barley, wheat, or oats.	Clover and rye-grass.
2	Winter and spring tares.	Barley, wheat, or oats.	Clover and rye-grass.	Potatoes and turnips.
3	Barley, wheat, or oats.	Clover and rye-grass.	Potatoes and turnips.	Winter and spring tares.
4	Clover and rye-grass.	Potatoes and turnips.	Winter and spring tares.	Barley, wheat, or oats.

It is added, that the rotation then begins as at first. It is suggested that Lot D. might continue in natural grass the first season, to diminish the labour of that year.

The advantages of gardens are also great in respect to the labourers themselves, as the attention they require prevents them from visiting the ale-houses. The Rev. Mr. Townshend has somewhere well remarked, that "there is a striking difference between the cottagers who have a garden adjoining their habitations, and those who have no garden. The former," says he, "are generally sober, industrious, and healthy; whilst the latter are too often drunken, lazy, vicious, and frequently diseased."

When lands are let to labourers, it would seem to be not only just, but advantageous, that they should never be charged higher than the price at which the farmer has them; and that the cottages themselves should always be kept at the disposal of the proprietor, and not to be suffered to pass into the hands of the tenants or holders of farms, as is too commonly the custom, frequently to the injury and disadvantage of the cottager.

Cottages may obviously be constructed in different forms; but in such as are merely intended for the farming labourer, all, perhaps, that is required is, that they be plain, simple, neat, and convenient.

It has been remarked by an accurate observer; that "the shattered hovels which half the poor of the kingdom are obliged to put up with, are truly affecting to a heart fraught with humanity. Those who condescend to visit these miserable tenements can testify," he says, "that neither health nor decency can be preserved in them. The weather frequently penetrates all parts of them; which must occasion illness of various kinds, particularly agues, which more frequently visit the children of cottagers than any others, and early shake their constitutions. And it is shocking that a man, his wife, and half a dozen children, should be obliged to lie all in one room together; and more so, that the wife should have no more private place to be brought to bed in. This description," says he, "is not exaggerated, offensive as it may appear. We are all careful of our horses, nay, of our dogs, which are less valuable animals; we bestow considerable attention upon our stables and kennels: but we are apt to look upon cottages as incumbrances, and clogs to our property; when, in fact, those who occupy them are the very nerves and sinews of agriculture." Nay, he is bold to aver, that more real advantages flow from cottages than from any other source; for, besides their great utility to landed property, they are the greatest support to the state, as being the most prolific cradles of population. He does not, however, wish to see the cottage improved or augmented so as to make it fine or expensive; no matter how plain it is, he thinks, provided it be tight and convenient.

The local situation of this sort of cottage seems, in general, to have been too little attended to; it should, however, be a dry, open, and rather elevated place, though by no means high, such situations having many disadvantages, with but few conveniencies. Rather low situations, provided they be perfectly dry, and free from damp, are perhaps always to be preferred, as they possess many advantages over the other. And in every case they should be built as near as possible to the farm on which the labourers who are to inhabit them are to be employed. The most suitable aspects for the front, are the different points of the compass from the south-east round to the north-west. Under such circumstances as these, cottages, in general, need not be elevated more than one or two small steps above the surface of the ground. But the ground-floors of such cottages should not, in any instance whatever, be suffered to be lower than the surface of the situation on which they are erected, as, where the contrary is the case, the health of the inhabitants must constantly be

in danger. The soil of the surrounding land should likewise, if possible, be such as that it may be advantageously cultivated as a garden, when converted to such a purpose.

The size and internal arrangement of this sort of building must of course be various, according to circumstances; but in general four divisions or rooms are sufficient, two of which must be on the ground floor, and the other two over them; the ground divisions may occupy a square of about ten or twelve feet. That into which the doors opens, as it will be cold in the winter season, may be divided, and fitted up in such a manner as to suit many convenient purposes in the way of store-room. And by this means the common room will be kept much warmer than where the outside door opens immediately into it.

Where the family is large, the upper part may also be partitioned into a greater number of lodging rooms, attention being always had to convenience and decency. In many cases, too, these points may be more fully accomplished by a particular arrangement of the beds; one being placed over the other, with different ways of entering into them, in the manner which we have already described in speaking of the accommodations of farming-servants. Where this plan is adopted, the sleeping-places should always be made as easy of ventilation as possible.

As the site of the farming-cottage must of necessity be small, it is of great consequence to make the stairs and other internal parts take up as little room as possible. With this intention, different kinds of staircases have been proposed, which may be seen by consulting the different plans contained in the annexed plates. In some cases a sort of ladder is conveniently adopted; and where two cottages are built together, room may be gained by reversing the staircases. It is, however, conceived by a writer who seems to have attended much to the subject, that all that is requisite in such buildings is "a warm, comfortable, plain room, for the poor inhabitants to eat their morsel in; an oven to bake their bread; a little receptacle for their small-beer and provisions; and two wholesome lodging apartments, one for the man and his wife, and another for his children. It would, perhaps, be decent, if the boys and girls could be separated; but this would, he thinks, make the building too expensive, and, besides, is not so materially necessary, as the boys find employment in farm-houses at an early age.

Much has been said respecting the forms of buildings of this description; but the square form, where no particular object is in view, though, perhaps, the most antient, seems to be that which affords the most conveniences. The circular plan has, however, been lately recommended, as being more cheap in its construction, especially when all formed of brick, and more easily erected. This is, however, obviously a method that does not admit of so much convenience in the rooms, or of sheds being so easily erected against the cottage on the outside; which is frequently necessary to be done. Beside, as they must of necessity stand alone, it is doubtful whether they can be built in so cheap a manner; and from the conical shape of the roof, where upper rooms are made, they must be

more low and confined, and not, probably, permit the articles of furniture to be placed with so much convenience in them.

Where expense is to be saved, it is always the best method to build two or more cottages together, and to let them have upper as well as ground apartments. The health of the cottager and his family will by this means be better preserved, as it is unquestionably more conducive to health to sleep upstairs than on ground floors.

Attention should likewise be particularly paid, in these buildings, to the rendering of them warm in winter, and cool in the summer. In this view, the walls and coverings should not be too thin. Where the roof is covered with tile or slate, which is by far the neatest and most durable, though by no means so capable of resisting the coldness of winter or heat of summer as thatch, the cielings ought to be lathed and plastered, having slides so constructed as to form air-holes, by which the rooms, as well as roof, may be cooled by the free circulation of air in hot weather. If the roofs of cottages were painted, or covered over with some white substance which would not easily wash off, it would, perhaps, tend greatly to prevent their being so much heated in the summer. Of the different substances employed for the coverings of the roofs of cottages, thatch is undoubtedly the cheapest; and the best kind of thatch is, perhaps, that which is prepared from a strong sort of reed found in some of the midland districts. I have been assured by a person of much information on the subject, that wheat stubble does excellently well for thatching cottages. He has known a coat of this material last thirty years without any repairing.

Where wheat-straw is made use of, it ought to be as little bruised as possible, the corn being lashed out, a mode which is common in most of the northern counties. Mr. Beatson speaks of a well-pitched brown paper, as forming an excellent light roof; and remarks, " that in the town of Dunfermlin, in the county of Fife, there is a church with a roof of this kind which has lasted near fifty years with very little repair, excepting a new coat of tar every six or seven years. This church is seventy feet long, and fifty feet wide, without any intermediate support for the roof, of which the whole original expense of preparing and tarring amounted only to fourteen pounds."

In regard to the materials for building cottages with, those will in general be found the least expensive that are nearest the places where they are to be erected. Stone is a very good and substantial material, and frequently much cheaper than brick; but good cottages may be built with many other substances more cheaply than with either of them; such, for instance, as different compositions of well tempered earths. These, when well prepared, will stand a long time. Most of the strong loamy sorts of soil are found to answer these purposes; but where there is much sand, clay must be mixed with the earth until it has the proper degree of tenacity and consistence. Clay alone is not, however, suitable for this purpose, as it cannot be rammed sufficiently hard, and is of course liable to crack in drying. Earthy compositions for this use should always be capable of being closely united by means of a heavy rammer made of cast-iron, as without this they have not sufficient stability.

A cheaper method is frequently followed, which is that of forming the walls of mire and straw well trodden together, and laid on in layers to the proper height; and sometimes a footing of stone or brick-wall is made about two feet in height, on which is placed a sill of strong timber, with upright quarterings at the distance of two feet, between which rounds of coarse wood are placed crosswise at the distance of five or six inches from each other, until the proper height; the spaces between the rounds are then filled with the composition of mire and straw, and the whole plastered with good mortar, which should afterwards be well rough-casted over: it adds also considerably to their neatness and general effect on the eye of the traveller, if they be well white-washed; a custom which is very prevalent in some part of Wales and which is annually performed at a very trifling expense. In some places, too, a sort of rough stone masonry is employed in these buildings, either alone, or stuccoed over; but this is in general a too expensive method.

In other places another method is followed in building the walls; a strong earth, such as is proper for making bricks, is formed into walls of a suitable height and thickness; after which they are left for some time to dry, when different sorts of light combustible matters are placed round them, both on the inside and out-side, and set on fire, by which means they are burnt into a kind of solid brick. The doors and windows are made afterwards by cutting them out of the solid walls, and the chimneys are built up with any suitable materials. We have been informed by a very attentive observer, that the best walls of the earthy kind, either for cottages or other outer walls, that he has seen, have been built of the mire or earthy materials scraped up from a turnpike or other road, after being well pulverised by the trituration of carriages or other means.

But of whatever materials the cottage may be built, it should be made strong, and well put together. If of stone, the wall should not be less than sixteen inches thick; and when of brick, not less than one brick and a half. The mortar that is employed ought to be well tempered, and mixed together without an improper, sparing of lime. The timber should likewise be well seasoned, as green timber soon decays, and, from its shrinking, frequently produces cracks in the other materials.

The flooring, for the lower rooms at least, may either be of earth properly prepared, or they may be laid with paving-tiles or bricks. The upper floors are probably the best when laid with good boards of a strong and durable kind; or they may be made, as we have already observed, of plaster, which is a good substance for such purposes, on account of its cheapness, and the little danger there is of fire, as well as its being in some degree more retentive of heat.

In constructing of cottages, care should always be taken to save fuel as much as possible, as it is a heavy expense to the labourer to be under the necessity of having different fires; the heat from his common fire should therefore not be suffered to escape without being applied to some further purpose in the œconomy of his cottage, which may often be readily done by different judicious contrivances. The upper apartments might, perhaps, be in some measure warmed

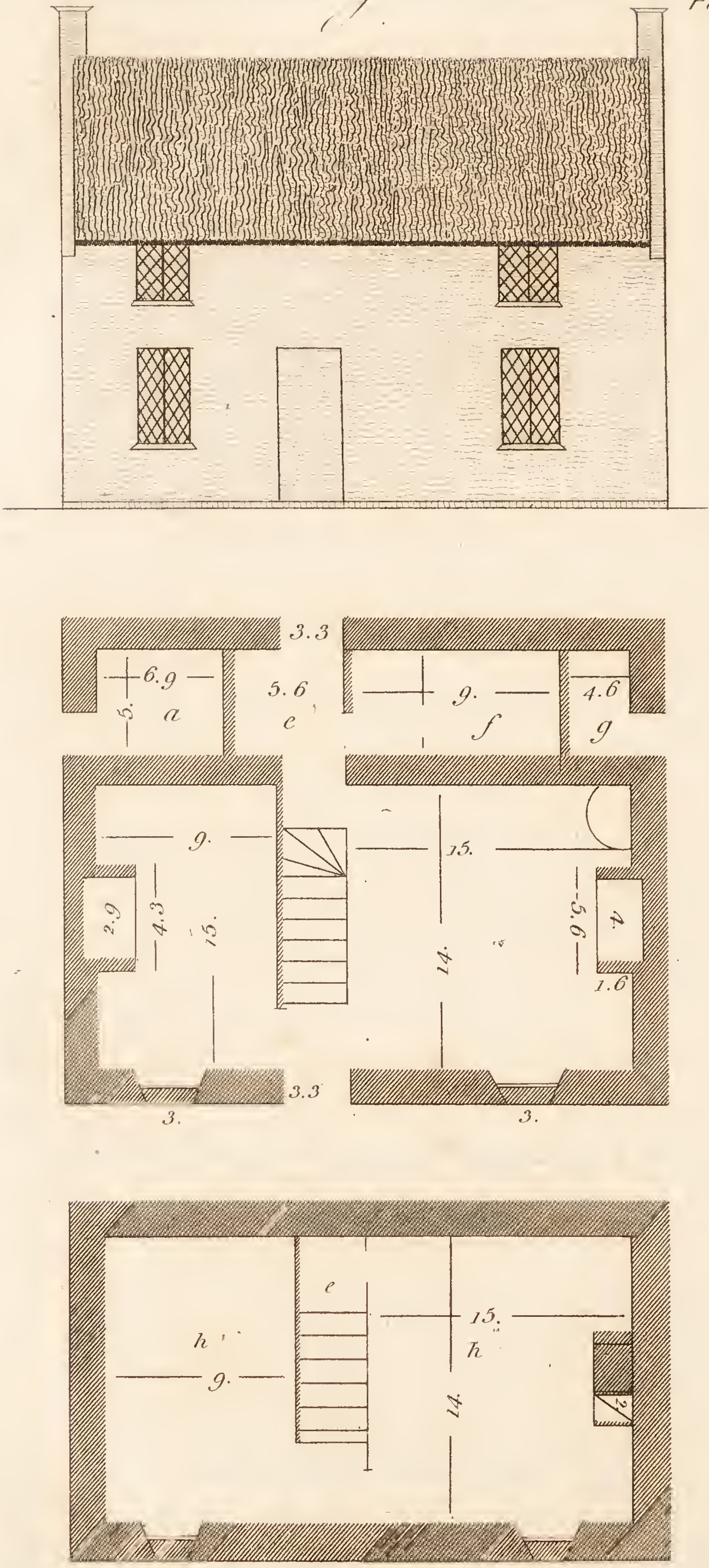
by means of proper flues being placed in the vents, where they pass through them; and by making the chimneys in these places themselves as thin as possible, or of thin materials, and such as readily transmit heat, as plate-iron, &c. On this subject Mr. Beatson ingeniously observes, that "in all apartments kept warm by a fire, it will be found that the air at the ceiling is considerably warmer than the air below. If therefore," says he, "in a cottage that warm air is permitted to ascend to the apartment, it is natural to suppose it will render that apartment considerably warmer." This, he thinks, may be accomplished either by sliding-hatches, or by gratings, in the least frequented parts of the floor, made so as to open or shut easily when required. When ovens are requisite, they ought to be so situated and contrived as that the heat which is dissipated from them may be thrown as much as possible into the rooms and apartments of the cottage. When the fire is not placed on the hearth, the heat might probably be made to warm the rooms or apartments more effectually, by having the grate so contrived as to come considerably forwards in the middle, somewhat on the plan proposed by the ingenious Count Rumford. Such a grate might be made at little expense, and be equally convenient for every purpose of the cottager. But the methods of rendering the upper rooms of cottages warm or cold, according to the particular season of the year, and by little expense or trouble, have yet been but slightly attended to, though they may undoubtedly be attempted with great success and advantage in many instances. A due attention to philosophical and chemical principles might, indeed, lead the builder to numerous interesting improvements, both in regard to the convenience and the healthiness of dwellings of every kind.

Another circumstance of the utmost importance to the cottager is, that of having near him good soft water; it is, therefore, of great advantage in the situation of cottagers to be near a running stream of water, or where there is a spring or soft water. When it is necessary to collect and preserve rain-water, in covered tanks or cisterns, the water should be drawn up by means of a bucket, or some vessel of a similar kind, in order to prevent waste. It is observed by Mr. Holland, that "a tank, ten feet in diameter, and ten feet deep, arched over, would at an easy expense supply twenty cottages all the year round."

Cottages, in order to render them clean and decent, should constantly be provided with small sheds; some parts of which may be employed as the repositories of different sorts of implements, coals, wood, &c. and others be made use of as a sort of pantries; but, above all, proper privies should be constructed, as being not only advantageous in point of decency and cleanliness, but highly conducive to health, by conveying away all noxious putrid effluvia.

The expense of building cottages must vary according to situation, the quantity and expense of labour, the nature of the materials, the ease with which they can be procured, and many other circumstances; but, in general, where no extraordinary labour or expense is required, it may be estimated that a good brick cottage, sufficient for two familes, will cost from eighty to ninety pounds; and one of the

Plan 1, Cottage House



a Kitchen
b Parlour
c Stair Case
d Calf Place or Woodhouse
e Passage & Place for Washing Dishes
f Dairy
g Privy
hh Two Chambers
i Closet

Neel. sc.

PL. LXII.
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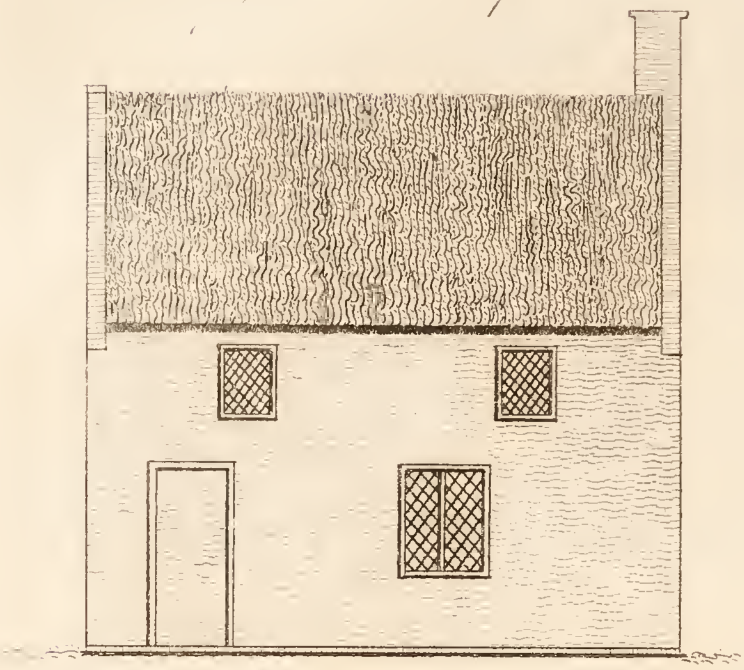
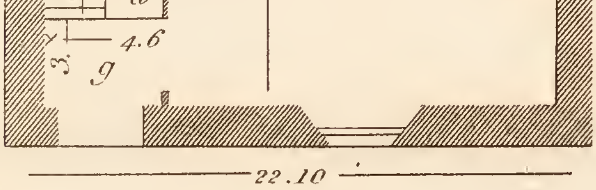
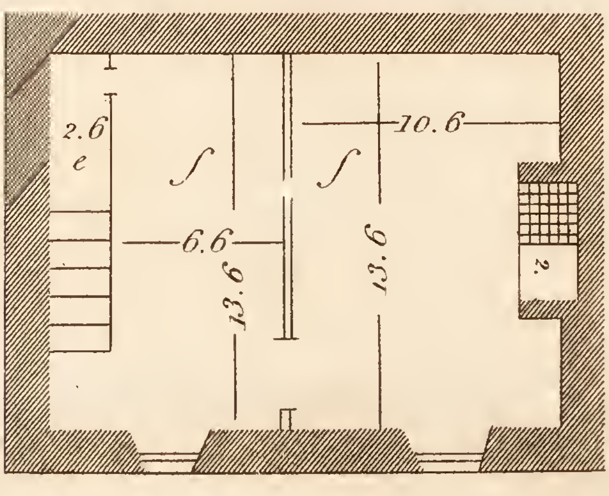
Plan 3. Cottage House for a Labourer.







a Kitchen
b Pantry
c Ladder in lieu of Stairs
d Cupboard
e Closet
ff Two Chambers
g Inner Porch

smaller sort for one family not less than fifty: if built with stud and mud, they may, however, come considerably cheaper, as from twenty-five to thirty pounds each.

In making calculations or estimates for the building of cottages of this sort, attention must, therefore, alway be paid to the nature of the plan, and the materials with which they are constructed, as well as the rates at which they can be procured: it is, however, remarked, on the authority of experience, that in those parts of the kingdom even where materials and workmanship are the cheapest, such cottages as are comfortable, healthy, and suitable for the decent country labourer, cannot be built if they be single ones for less than fifty pounds, and when double, or two dwellings under one roof, for less than ninety pounds, which is nearly as has been observed above. Where inclosures of waste or common land are made, it will, however, frequently be necessary to build cottages on such plans, and of such sorts of materials as may render the expense of them considerably lower than the above. This may, in some cases, be done by making the walls of mud, such as soft mire and straw, well incorporated together by treading with the feet, and afterwards gradually applied layer upon layer, to the height which may be necessary. This mode of building is common in the western districts, and is probably the cheapest of any. According to Mr. Crocker, a cottage formed of this kind of materials may be erected for the trifling expense of twenty-seven pounds. And where stones are scarce, others with footings of stone-wall for a strong sill of timber to rest upon, with upright quarterings at the distance of two feet, having rounds of rough wood in the manner of ladder-work, six or seven inches apart, to the proper height, the intervals between being well filled with well-wrought straw and mire, or what in some places is termed *cab dab*, and the whole plastered over with good mortar, and rough-casted, may be constructed for fifty-eight pounds.

Mr. Kent has given different useful plans and estimates for the building of cottages of various kinds, but which stand higher than the above when formed on the cheapest plan.

Various plans of useful farm-cottages of different sorts may be seen in the large work. In plate LXI. plan 1. is the representation of a cottage-house used in Rutlandshire. And in plate LXII. is shown another at plan 2. proper for the cottage labourer.

Besides these, there is another mode of constructing cottages that may be had recourse to with œconomy and advantage in particular situations; this is, that of building in what is termed *pisé*, or simply by compressing well-wrought warmy earth in moulds or cases contrived for the purpose. It is a method that has been long practised in the vicinity of Lyons, in France, with great benefit, and has been attempted in this country with equal success. It is particularly recommended by the cheapness of the materials that are made use of; the facility with which they can be procured in almost every situation, and the vast saving in time, carriage, and labour, that attends it; and it is said to afford buildings that are equally neat and durable. The manner of preparing the materials, and performing the work, with representations of the different implements that are necessary to be

employed, have been described with much accuracy and correctness from the publication of M. Cointeraux, by Henry Holland, Esq. and inserted in an Appendix to the First Volume of Communications to the Board of Agriculture, which may be consulted on the subject.

In the letting or management of cottages, there are several circumstances that require to be more attended to than seems in general to have been the case. It should always be the object of the proprietors of farms to guard the labouring cottager, as much as possible, from being injured by any improper conduct in the common farmer, while at the same time his labour is effectually secured to the farm; and also, that his little rent be exacted in the most easy and convenient way. The first may, probably, be the most easily effected by the proprietors of lands keeping the cottages that may be upon their farms in their own hands, and not suffering their tenants to have the direction or management of them; and by their having just and equitable stipulations in respect to labour entered into between their cottagers and their tenants. The latter may be accomplished in various ways; but that which is practised in some of the midland districts, of deducting from their wages, at the close of every week, a small part proportioned to the value of their labour, and the annual sum which they pay for their cottage, in order to discharge their rent, seems the least objectionable.

From what has been advanced, it must be sufficiently evident that the building of proper cottages for farming-labourers is not merely a matter that interests the proprietors of land, insomuch as it renders the situation of that useful class of workmen more comfortable, but which, at the same time, has a great tendency to promote the full and complete cultivation of the soil.

SECTION IV.

Inclosing of Land.

THE beneficial consequences that necessarily result from the inclosure of land, whether in a state of waste and common, or otherwise, are numerous and important. In addition to those of ascertaining and securing the property, it holds out not only the most ready and certain means of improvement in the cultivation of the former, but in such as have been long under the plough, or any other system of management; being equally useful in its tendency to bring them into the most perfect and advantageous state of culture. Without inclosing, however, much attention may have been paid, or expense incurred, in carrying on the various processes that are requisite in preparing land for the reception and growth of good crops, whether of the grain, root, or grass kinds, it is obvious that they can neither be conducted under the most beneficial management, nor yield the full advantage they are capable of, while they continue in a free and open state. Where the land is in a state of arable cultivation without inclosure, the crops, of whatever sort they may be, must constantly be exposed to depredations of various kinds; and if in the state of

grass or pasture, injuries of the most prejudicial nature must frequently be unavoidably sustained. The great advantage and importance of inclosing land is still more fully demonstrated in the differences which may be observed in respect to the quantity and value of the produce, in such as have been thus divided, over that which is cultivated in the state of open or common-field.

It is well observed by an intelligent practical writer, that "in proportion as a field or a country is bleak, naked, and exposed to chilling blasts and winter storms, in the same proportion will it be unproductive, compared with lands more favourably situated. Inclosing is a mean of obtaining by art, a certain degree of that genial warmth so essential to the production of valuable crops, but which nature is not always pleased to bestow. Every day's experience," continues he, "where grounds are sheltered from the violence of storms, as by garden-walls, or by plantations of forest-trees, they are more productive, and vegetation is earlier, than in others similar in every respect unless in regard to exposure. How many instances," says he, "occur to establish this fact, in respect to large fields; as well as to gardens, orchards, &c. Let the observant farmer, who possesses an inclosed farm, examine that part of a field where, owing to the decay of the fence, the wind enjoys a free passage; and he will be satisfied of the benefit of inclosing, from the superiority of the crop in the other part of the field over that which is within the influence of this additional exposure. While on the other hand, the possessor of an open field farm, by examing the superior verdure that takes place in any part of an open field that is by some accidental circumstances sheltered in a remarkable degree, may satisfy himself, that were the whole equally sheltered the produce would be more abundant." And by another author, that "as the warmest air lies nearest the surface of the earth, being that portion of the atmosphere which, like a blanket, nature spreads over the soil and its productions, fences of all kinds tend more or less to prevent such a valuable covering from being blown off by the winds."

But, besides these, there are other benefits to be derived from the judicious fencing in, or inclosing, of land, proceeding from the warmth and shelter which it affords to cattle of various kinds. Under these circumstances, animals are invariably found not only to advance in flesh much more rapidly, but to be freer from disorders, than when kept in situations that are bleak and exposed, and which cannot afford warmth or shelter to them. "If," says the author we have first quoted, "any person entertain doubts respecting the inclosed pastures being better adapted for rearing and fattening live-stock than open fields, he may easily satisfy himself by comparing the live-stock in an inclosed parish with that of one in the open field state. He is much mistaken," he says, "if he will not find them in the latter not only fewer in number, but each animal, on an average, thirty or forty per cent. inferior in value. In short, inclosing," he thinks, "may be denominated the first step towards effecting improvements in the breeds of the different species of live-stock. And on the whole, this," he conceives, "is reasoning on plain established facts, and on such as afford the

most indubitable evidence of the superiority of inclosed fields, whether for tillage or pasturage. Were further proof necessary, the additional rent which is every where paid for inclosed land beyond that paid for land of an equal quality in the open field state, is sufficient," he contends "to place the matter beyond all possibility of doubt."

By means of inclosing, the value of the land is, in most situations, considerably improved. The proportion of the increase of value that may be made in this way, whether the inclosed lands be in a state of lease or in the hands of the proprietor, must, however, depend greatly on the nature of the soil and the system of management that is pursued. It is observed, that "lands of a middling quality, good turnip soil for instance, are probably benefited to a greater degree by inclosing than those of superior or inferior quality. Lands of this description, in the open-field state, may, it is asserted, be considered as rented to the full at fifteen shillings the acre; whereas there are few instances where such lands, when inclosed, are rented under twenty shillings; an advance so great as to afford the proprietor a handsome profit, after paying the interest of the money expended. Thus does inclosing not only increase the quantity and quality of the produce, so as to enable the farmers to pay his landlord a higher rent, and to contribute a larger share to the revenues of the state, but from so many people being constantly employed in making and repairing the fences, inclosing, in this view, must also be considered as beneficial.

There are, however, in many districts, extensive barren and mountainous tracts of land that can never be inclosed with the least prospect of advantage; or, if they could, that could never derive any amelioration from such a measure: the only means by which they can be improved is by being rendered, in particular situations, more free from injurious surface moisture, by proper drainage, or by the introduction of better and more perfect breeds of the several kinds of animals which it may be necessary to turn upon them.

In some other situations, too, as where the land is capable of being cultivated almost constantly under the arable system, inclosing, at least with any kind of high fences, may be in a great measure, if not wholly, unnecessary. But, in general, where lands are cultivated under a system of management such as that of alternating grass or other kinds of green crops with those of grain, and thereby combining improvement in the breed of live-stock with that of arable cultivation, the practice of inclosing must always be necessary and advantageous.

But notwithstanding the advantages that in various points of view thus evidently result from the inclosing of land, the practice is far from having been so much encouraged or attended to as its utility and importance would seem to demand. This may have proceeded partly from the difficulty that must necessarily attend the business in every case, and especially in waste or common-field lands, from the diversity of claims, and partly from the improper conduct or mismanagement of those who have the direction of it.

It may, therefore, not be improper to take notice of some of the

leading circumstances that ought to be regarded in directing the means of such inclosures.

In the inclosing of wastes and commons, much opposition and delay often proceed from the causes just mentioned, as well as from a neglect of, or inattention to, proper accommodation in the small allotments; such as those of cottagers, and other labourers who have claims.

In the management of inclosures, therefore, it is necessary that due attention should be had to the rights and interests of cottagers and the labouring classes, who have small claims, as well as those of the larger proprietors. Mr. Billingsley, in his able report of the Agriculture of the County of Somerset, has, indeed, observed, that whether the inclosing of commons be accomplished "by the unanimous consent of the parties claiming rights who delegate power to commissioners, chosen by themselves, to ascertain their validity, and divide accordingly under covenants and agreements, properly drawn and executed for the purpose, or by act of parliament obtained by the petition of a certain proportion of the commoners; it is manifest that the rights of the cottager cannot be invaded, since, with respect to legal or equitable construction, he stands precisely on the same ground with his more opulent neighbours." And in regard to his interest, he remarks, that, in all the cases that have fallen under his observation, "inclosures have ameliorated his condition, by exciting a spirit of activity and industry, whereby habits of sloth have been by degrees overcome, and supineness and inactivity have been exchanged for vigour and exertion." The reduction of the poor-rates in many of those parishes where inclosing has been practised is, he thinks, a strong proof of the truth of the position.

In conducting the business of an inclosure, it would seem to be the most proper method for the commissioners, after ascertaining the nature and quantity of land, and marking out the necessary roads, bridges, &c. in the most easy and convenient directions, to apportion out the allotments of the smallest proprietors first, without the least distinction of persons, so as to render such allotments as suitable and convenient as possible for those who are to occupy them; as it is sufficiently obvious that the small claimant might as well have no allotment at all, as to have it at such a distance from his dwelling as to be managed with great inconvenience and disadvantage, or in a way that must prevent him from going to and performing his daily labour; under such circumstances he would most probably have no alternative but that of disposing of his little property, which might otherwise be of great utility to him, to his more opulent neighbour. From such small claimants they should progressively advance to the largest proprietors, having constantly an eye to the accommodation and convenience of each, but without permitting any injury to be done thereby to another. This is unquestionably a very difficult as well as troublesome part of the business; but by proper attention, a complete knowledge of the subject, and proper management, much may be satisfactorily accomplished.

In case of the town being situated near to, or in the middle of, the inclosure, the allotments of the different proprietors may often very properly be laid out in such a way as to join, or nearly join, to the farm-houses; and they should likewise be as much in squares as their nature will admit of; but where the case is the contrary, the allotments at a distance ought to be so distributed as to render them most advantageous for occupation as farms, on which houses and proper offices may be built, regard being always had to the convenience of water, and to different sorts of land, as well as many other points of constant importance to the farmer.

It would probably, too, be a measure of sound policy, as well in a national as other points of view, to have a provision in bills of inclosure for the building of a certain number of cottages, proportionate to the extent of the inclosed common or waste, with a small allotment of land annexed to each, at least as much as is sufficient for a garden, which, in general, need not exceed a rood. These cottages should be solely destined for the use and advantage of such poor labouring persons as belong to the parish. Such a regulation as this would probably be attended with many good consequences; it would render the business of inclosing less objectionable to the labouring cottager, promote the cultivation of land, and at the same time have a tendency to lessen the expenses of the poor. For it is a curious and important fact, that in most parishes where no inclosures of waste lands have been made, the rates for the support of the poor have been increased to an astonishing degree: in some instances, even in a treble and quadruple proportion.

It has been suggested that, in making inclosures, something more substantial should be given to the poor cottager in exchange for his benefits, whether they be considered real or imaginary, which he derives from his common, than the hope of participating with the whole in the general advantage which may be produced. Various clauses have been provided in different acts of inclosures in this intention. In some, much dispute and inconvenience has been avoided by inserting clauses for increasing the allotments of those owners and proprietors whose property may be above the annual value of five pounds, and under ten, so as not to exceed the proportions allotted to any other proprietors whose property may amount to the annual value of ten pounds. The spirit of which seems to be: "First, that every proprietor whose property is above the annual value of five pounds, and under the annual value of ten, have an extra allotment; and, Secondly, that the value in this extra allotment shall, as nearly as possible, be inversely proportionate to the property to which it is attached; the commissioners consequently taking care that in no instance the allotment to the smaller property shall exceed in value the allotment to the larger." And in respect to proprietors whose property is under the annual value of five pounds, by allowing them double proportions on a certain part not to be inclosed; or by suffering them to have allotments in similar proportions, according to their properties, to those whose property was above five pounds.

With the view of benefiting the still more poor tenants, or renters of cottages, it has been farther suggested, that by the providing of a clause for the purpose of allotting a portion of land for the convenience of building a number of solid, convenient, and airy cottages, to be held in trust for the parish, many advantages might have been gained.

It is well observed by a noble writer quoted before, that "upon an inclosure, if the owners choose it, the labourers who keep cows may be placed in a much better situation than they were, inasmuch as inclosed land is more valuable to occupiers of every description than commons and open fields. Garden ground may also be allotted to them, as well as others, which cannot be done while the land remains uninclosed." He is persuaded that "where these things are attended to, very few objections to an inclosure will arise on the part of the labourers, and that the land-owners will have the satisfaction of benefiting the poor, and at the same time of making their own property more valuable, by adopting what, in all probability, will be the means of keeping down the poor-rates."

Wherever the system of inclosing is adopted, much care and circumspection is necessary, in order to guard against expense in the appointment of persons for the conducting and managing of the business. None but such as are known to be fully capable should be fixed upon, either as solicitors for promoting and procuring the act of parliament, when necessary, or commissioners for transacting and arranging the business of the inclosure. After such act has been obtained, it is a matter of great consequence, in appointing the latter, to have them from the vicinity of the inclosure, that they may be acquainted not only with different local circumstances and peculiarities of the place, but the nature of the soils, and the best means of their being improved. Some of them, too, should always be persons who have a perfect knowledge of the forms and modes of conducting the business, and a practical acquaintance with accounts, and the prices of making all sorts of fences, gates, roads, bridges, drains, &c. as well as sufficient information both of the theory and practice of agriculture itself; much of these various sorts of knowledge being constantly required in the conducting of an inclosure.

Where persons are thus qualified, and without it errors and mistakes must be continually committed, two, or at most three, commissioners will generally be fully adequate to the execution of the business, even in the most extensive inclosures. And in many cases where the waste land to be inclosed is small in quantity, one intelligent commissioner may be sufficient for the purpose.

Where country solicitors are employed, they may act as clerks to the commissioners, by which a considerable saving of expense may often be made; or this may, in most cases, be accomplished by the commissioners entering their own minutes and orders, which, in general, is attended with but little trouble. The office of surveyor, being in general expensive, should be cautiously disposed of. The best mode is probably that of fixing an adequate sum for the transaction of the whole of the business that may be requisite after

the act has been procured; care being taken that the person who engages be duly qualified, and of established character, for the office. Such a plan would not only save much trouble, but, in different instances, considerable expense to the proprietors.

Another circumstance which ought to be particularly regarded in the inclosing of commons, is that of no greater delay being permitted in giving the different proprietors possession of their allotments than is absolutely requisite. If these several points were sufficiently attended to, there would probably be very little reasonable objection made to the system of inclosing; as those which have been advanced, on the grounds of injuries done to the breeding of cattle, the expenses of farm-buildings, the deterioration of the quality of wool, or the diminution of its produce, by a reduction in the number of sheep, and the lessening of the rental value of such estates as are in the neighbourhood of inclosed commons, are, when fully examined, too feeble and unsatisfactory to deserve much regard.

It is forcibly observed by the able writer of one of the county reports on agriculture, that "when the inclosing system is appreciated by its obvious tendency to increase the produce of land and the demand for labour; to augment the rate of wages to the husbandman, and to lessen the amount of the poor-rate; it is a subject of regret and astonishment that so few means have been devised by the legislature, either to facilitate or extend its grogress. How much is to be done this way," says he, "a general inclosure act, unfettered by tedious and expensive formalities, would speedily manifest. From the very great number of private acts which have passed within the last twenty years, such general principles might," he supposes, "be selected for its basis, as to implicate almost every possible variety of claim, interest, and property. An act thus constructed," he thinks, "might, without hazard or injury, be entrusted to a given number of justices at the quarter sessions, to dispense its powers, and control its execution; and such justices," he conceives, "perfectly competent to determine on the propriety or impropriety of any proposed inclosure. "Thus," continues he, "a total extinction of parliamentary expense would encourage inclosing on the smallest scale; and, with advantage not to be despised, would accommodate the most extensive."

That such a measure is calculated to promote the advantage of individuals, as well as that of the nation, cannot be much doubted by those who have at all considered the nature of the subject. We therefore hope that a general act of inclosure may, at no very distant period, be obtained, notwithstanding the injudicious, illiberal, and very inconsiderate opposition it has hitherto experienced; by which those numerous commons and waste lands that have so long remained in a barren and unproductive state, to the disgrace of the country and the reproach of agriculture, may be put under a system of cultivation and improvement.

The benefits which would be derived from the general inclosure of commons would no doubt be various. In addition to the increase in the value of such lands to the owners, which, as has been observed, would be considerable in many places, especially near large

towns*, in regard to the public it would be of still more extensive utility. It would, likewise, be the means of raising and supporting a more numerous, as well as a much better breed of neat cattle and sheep, and of preventing the latter from being attacked and destroyed by disorders, such as the rot, &c. In consequence of such a system, the markets would not only be better supplied with fat cattle and sheep, but with different sorts of grain and vegetables. Besides, the necessity of making furrows, drains, ditches, and other passages for conveying away and removing the superabundant surface water, in such cases, would have a great effect in rendering low swampy situations more healthy and comfortable for their inhabitants. Much immediate as well as permanent employment would, likewise, be created for the labourer in husbandry, and the rural artificer; while beggary and robbery, if not wholly prevented, would probably be rendered much less frequent.

On population, too, there can be little doubt but that it would have a good effect, from the great increase of corn and vegetables of different kinds, as well as of cattle; and, as has been just ob-observed, the augmented demand for labourers and artificers of various descriptions which it must produce. The facts which we possess on the subject are, however, yet probably too few to draw any certain conclusions from.

Therefore, in whatever point of view the business of inclosing common or waste land may be contemplated, it promises advantages of the most important kinds. The humble cottager, the rich proprietor, and the nation at large, must be equally benefited by the salutary influence of such a system whenever it is allowed to take place.

Fences.—In the inclosing or dividing of lands by means of fences, regard is necessary to be had to a variety of circumstances; such as the size of the farms, and the nature of them, as well as the uses to which they are to be converted; the climate, the elevation, situation, and nature of the soils; the particular objects that are in view, or to be expected from them; and the materials of which they are to be formed. It is sufficiently evident that such inclosures as are chiefly intended for the production of grass ought to be smaller than those in which grain is mostly to be cultivated and grown. On the lighter sorts of sandy or gravelly soils, too, the divisions should be small in proportion to their dryness, and the particular kinds of crops which can be raised and cultivated most commonly, and to the greatest advantage, upon them. And the inclosures on sheep downs, and other lands where there is considerable elevation, should, probably, have a reduction of their extent proportioned to their height and the dryness of the grounds; the thickness of the hedges being, likewise, regulated by the same circumstances. We are, however, assured, on the authority of an able agriculturist, that

* The increase in the value of waste land, which may be effected by this means and that of proper drainage, is fully shown in an useful Table, drawn up by Mr. Parkinson of Asgerby, steward to Sir Joseph Banks, and inserted by Mr. Young in his View of the Agriculture of the County of Lincoln.

in forty years' experience he has always found that the grass would begin to burn, and the grain to suffer, first, in a dry summer, in *small inclosures*, and particularly near the hedges. Where the divisions are large, and the soil moist, great care must be taken in making proper drains to supply the want of ditches, which answer the same purpose when properly formed. The frequency of full-grown hedges, high ditch-banks, and trees, on the first sort of ground, has considerable effect in preventing such lands from becoming too dry for the successful growth of different crops. It is stated by a judicious writer, "that "equal care should be taken to guard against the extremes of too much exposure, and that of creating a thick damp atmosphere, as the health, thrift, and beauty of animals are greatly promoted by proper shelter and a due circulation of air. "For instance," continues he, "a low, flat, and naturally damp situation, divided into small inclosures by high hedges and broad shaws, especially if they abound with trees, is totally unfit for the production of corn crops, and still more if it be exposed to a northern aspect and inclosed with wood. In that case the sun is too much excluded, and the damp cannot be sufficiently drained and evaporated to prevent the redundancy of moisture from chilling the better plants, leaving an herbage that will be of no value to a farmer. On the contrary, if it be free from adjoining woods, be drained, and the ditches kept well cleansed, it would make good permanent pasture or meadow. If, in addition to these, the hedges should be kept closely cut or clipt*, the fields large, the trees† trimmed to the height of twelve or fifteen feet, and every possible method taken to promote the free admission of the sun's rays, with a perfect drainage and evaporation, it would be fit for many of the purposes of aration."

But though the stagnation of the air in confined situations may have an injurious effect on vegetable as well as animal life, by preventing the proper degree of evaporation from taking place; it is not less injurious to the feeding of animals than the growth of vegetables, when it circulates too much or too rapidly over a district, especially where the elevation is considerable, as in mountainous and hilly situations; for in such cases the warmth of the animals is too suddenly carried off by the too frequently renewed application of cold air, and the growth of the vegetable thereby much checked and retarded. In such situations, therefore, particular attention ought to be paid in planting the hedges so as best to break off the winds they would be the most exposed to. "It is as well," says the writer we have just quoted, "for the purpose of shelter, shade, and equable warmth, as of occasional fresh supplies of grass, that the Leicestershire graziers have founded their opinion, of fifty acres in five inclosures being equal to sixty in one."

* Where hedges are clipt, they should be left wide at the bottom, and tapered up to a ridge at the top; for where they are left broad at top, as is often the case, they are apt to smother the young shoots below, and the bottom soon grows thin.

† There should, probably, be very few trees in hedge-rows.

It would seem, therefore, that whether land that is to be inclosed be intended for the purposes of pasturing, or the production of grain, root, and such-like crops, it will be the most advantageous to avoid the extremes of very large or very small inclosures; but that in the latter cases they may be left more large and open than in the former. From seven or eight to fifteen or even twenty acres, according to the extensiveness of the farm, for such sorts of land as are chiefly to be employed in the way of grazing, may, in general, be the most proper; and from eight or ten to thirty, in proportion to the magnitude of the farm, in common, may be the most suitable for those of the arable kind. But whatever be the dimensions adopted for the inclosures, great attention should constantly be had to the convenience of water, the position of the ground, the purposes of drainage, and the bringing together as much as is easily practicable of lands of a similar quality, or such as can be cultivated and sown under the same circumstances, though it may tend to render them equal in regard to size, and irregular in form. Where, indeed, there are no circumstances arising from the nature of the situation that prevents their being formed in a regular manner, the size of the farms and the course of the crops that can be most beneficially cultivated on them should be principally regarded; as by their being thus made to suit the nature and extent of the farms, conveniences may be gained in the business of cultivating them, as well as in taking off their products, that no other mode of division could probably afford.

It may, on the whole, probably be concluded, that the more equable, in respect to temperature, such fields as are intended for pastures can be made by means of judicious fencing, provided they be properly drained, and a due circulation of air preserved, the better they will fatten the animals that are kept in them; but that in grounds where grain and root crops are to be cultivated, except in elevated, hilly, and very exposed situations, the size of the inclosures should be larger, and the fences less calculated for the purposes of shelter, as the free and equable admission of air has great power in rendering the growth of such kinds of crops healthy and vigorous, as well as in preventing them from being injured by a variety of causes to which, under other circumstances, they must be exposed: besides the health of mankind, as has been already observed, would in many cases be considerably benefited by the adoption of such a system of inclosure.

Fences are of different kinds, and constituted of different materials, according to the situations and particular circumstances under which they are made; but, in general, so far as the farm is concerned, they may be considered either as walls and palings, or hedges and ditches.

It must be obvious, from the nature of these different fences, that one kind of them, from its being formed of some sort or other of dead material, must, in every instance, from the very period of its being completed, be constantly getting worse, or proceeding to a state of decay; while the other, as being composed of various sorts of living plants, where properly managed and attended to, must be advancing to a state of greater improvement and advantage. This difference fully shows the advantage of having recourse to one sort

of material in preference to the other, wherever there is a possibility of doing it; but in some districts, and many exposed situations, it is frequently a matter of great difficulty and expense to procure such sorts of materials as would be the most beneficial for the purpose; in such cases, that sort must of course be employed which is the most ready and convenient. The dead kind of fences, whether they be formed of stones, wood, or earth, can seldom, from the expense, be made by the farmer of such heights or in such ways as to be of much utility in affording shelter; they will, therefore, be the most proper for inclosing with, where that forms no part of the intention of the farmer or proprietor who is making the inclosure. Where this sort of material is employed as a fence on elevated or hilly and exposed situations, it should be constructed in a more firm manner, and be made to stand higher, than when used in lower and more sheltered situations.

Walls.—Where stones are abundant, and other sorts of materials scarce, the outside as well as the other fences are frequently made with that sort of material. In the construction of walls, different methods are pursued in different districts; they are sometimes made simply of stones, sometimes with stones and lime or mortar, but perhaps more frequently by interposing between the stones some earthy substance, such as clay, mud, turf, or any similar matter, and afterwards dashing or pointing them with mortar or not, according to the particular circumstances of the walls. The first sort are denominated dry stone walls*. It must be obvious that where any sort of earthy material is employed in the forming of these kinds of fences, they can neither be so good nor durable as where stones alone, or stones with lime, are made use of; as from the continual action of the air, and the distending powers of frosts, such substances quickly decay and moulder away, by which means the stones are left naked and loose, and the fences soon fall into a state of ruin and of little utility. Walls of this nature should, therefore, only be had recourse to where there are not materials for constructing the more lasting kinds. Stones, when made into walls in the dry way, if the work be properly executed, constitute a very good and durable fence; but a better and more lasting, though in many situations a considerably more expensive method, is that of using lime; as by this means the walls are bound and cemented together, and prevented from going away and falling down.

In preparing the ground for the foundation of walls, it should always be dug up to such a depth as that the frost may have no effect on it; where the surface of the earth is sufficiently level, it is found a more preferable method to lay the foundation of walls on the turf than in a slight trench only, as in this way they are not, probably, so liable to sink and give way. The foundation or bottom of this sort of walls should be two feet and a half wide, and the upper part from ten to fifteen or twenty inches, according to their height, which must vary in proportion to the nature of the situation and other circumstances; but from five to six feet is a very common and good height. They should always be coped at the top, either by means of stones

* In some places this sort of fence is termed *dyke*.

laid edgeways, or with turf about six inches in thickness, put on in the form of an arch; the former is, however, by far the most advisable method, as being the most durable, and affording much difficulty to animals in their attempts to get over.

In some places wall are made partly with a cement, and partly dry, and are termed *list walls*; but where a flat bed of stone can be had, they are generally constructed without the use of any cement whatever, and if the work be well executed, they will continue a long time. In the building of dry stone walls, two masons ought constantly to be employed opposite to each other, in order that the surface of their work may be kept perfectly level. Long stones should likewise be selected for the purpose of being placed occasionally across the wall, in order to bind it well together. These are termed *throughs*, or *through stones*, and are commonly put about the middle of the work, in the proportion of nine or ten to every rood of seven yards.

The expenses of building these different sorts of walls in Somersetshire, Mr. Billingsley states to be, per rope of twenty feet, for the *list wall* 11*s*. 6*d*.; and for the dry stone wall 8*s*. 3*d*.

When stones can be got within a wheeling distance, or about sixty or seventy yards, it is observed that the cost will be reduced about two shillings a rope; and that if the wall be wholly made with cement, it will be enhanced about two shillings and sixpence the rope.

And in Northumberland the charge for *winning and walling* is from five shillings and sixpence to six shillings and sixpence the rood, of seven yards.

The stones employed in the constructing of every sort of wall should be rendered of as flat a form as possible, either by quarrying, or some other means, before they are made use of; as by such a practice fences of this sort are not only constructed with much greater facility and expedition, but become far more strong and durable.

In building of walls with stone and lime, the early part of the spring, or the beginning of autumn seem by much the most suitable periods for the purpose, as they cannot at such seasons be much injured either by the destructive effects of frost or the too drying poperties of great heat.

In the forming of walls, or what in some districts are termed dykes, with earthy materials, or with a mixture of stones and such substances, the methods that are followed vary according to the circumstances of the particular cases. In some, two or three feet at the bottom is constructed with dry, round, or flat stones, in a sloping direction, upon which a coping of broad flat stones is laid, so as to project a little upon the sides, upon which rough stones are again placed so as to form a kind of ridge: in other instances wrought clay is employed in the way of mortar between each course of stone; and in others again turf cut from the surface of the land is intermixed with stones taken from the fields, layer upon layer. This last is a kind of fence that may be formed in almost any situation at a trifling expense, and which may serve the purposes of a temporary

inclosure in many cases. But if the stones be left out, and the whole wall or bank be raised in a sloping direction with turfs well filled up behind, a still more firm and solid fence may be made.

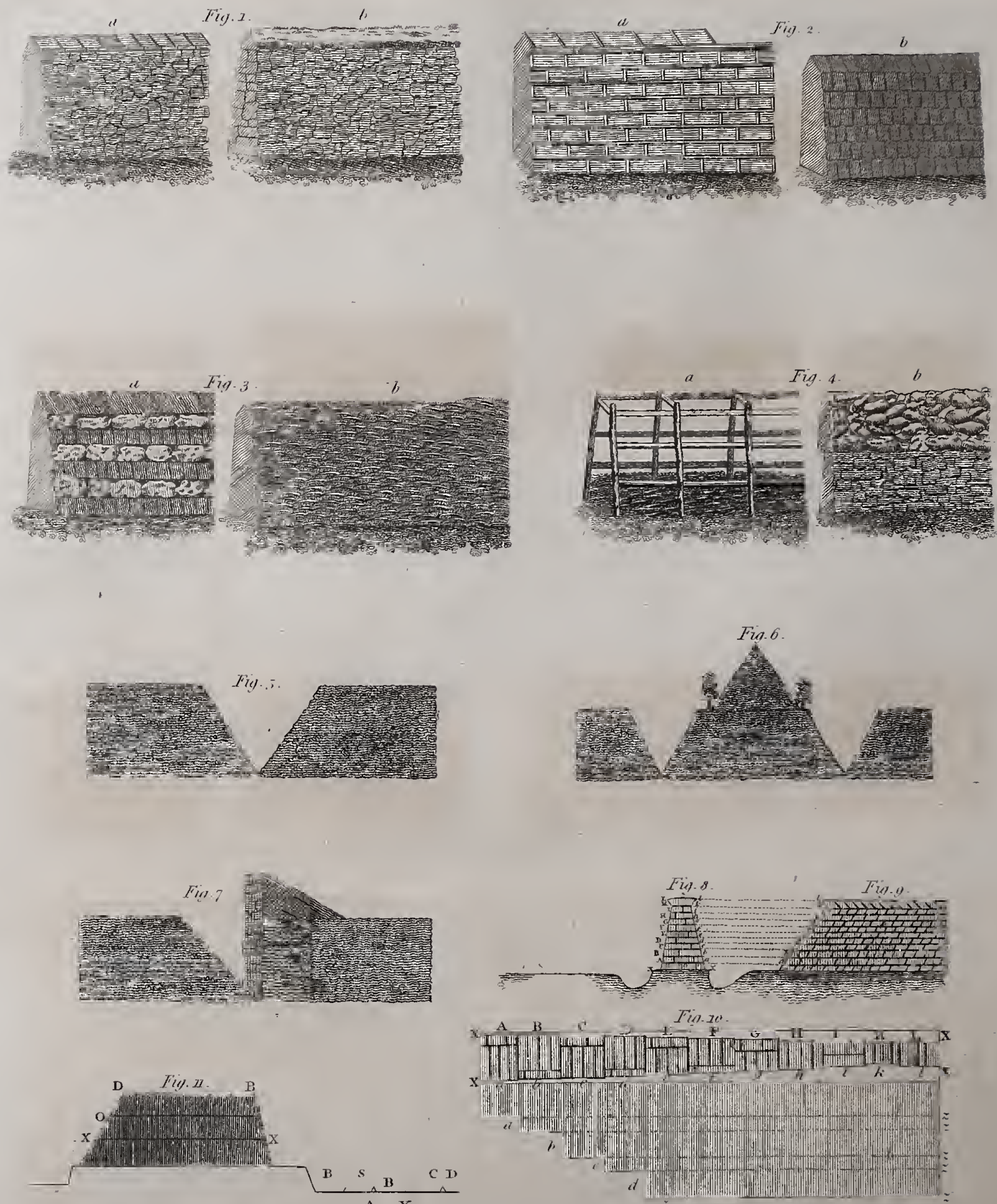
On stone walls Mr. Middleton very justly observes, that "so far as the mere purpose of a fence is intended or desired they are the best of all, as they occasion the least waste of ground, do no injury to the corn crops, do not harbour vermin, and are free from the weeds and rubbish that invariably accompany live hedges. Nor be it forgotten," continued he, "that they nearly exclude the greatest of all vermin to a cultivated country, *hunters*."

It is remarked by an accurate practical observer, that the greatest part of the walls or dykes of the kind that have been just described, which he has seen, were made of considerable thickness, with a ditch on each side; the heart of the dyke being made up with the earth that had been taken from the ditches, and only a thin facing on each side was built of a solid *feal* (turf) from top to bottom; "the consequence," says he, "of which is, that as the loose earth that is thrown into the middle of the dyke subsides much more than the feal on each side, the top of the dyke sinks, and of course the two side-walls are pressed too much upon the inside, so as to *bilge* (or swell) out about the middle, and quickly crumble down to dust." To avoid this inconvenience, he has always chosen to build dykes of this sort much thinner than usual, they being only three feet and a half or four feet thick at the bottom, fifteen or eighteen inches at top, and five feet high, taking care to have them built in such a manner as that every sod (feal) from top to bottom binds the joinings of the others below it, with as much accuracy as the bricks in a well built wall. The uppermost course of feal is cut a little longer than those that are immediately below it, and placed with the grassy side uppermost, so as to project a little on each side, which is not only of use to throw the water a little off the wall or dyke, but is also of use in preventing sheep or cattle from attempting to jump over it so readily as they otherwise might do. Further experience has, however, taught him, that in many cases the coping will be more durable if it consist of a row of feal set on edge; for when the flat-laid *feal* are withered by the sun in summer, they become very light, and are apt to be blown off by the wind singly; whereas, when they are set on edge, as they lean upon each other, they are bound so firmly together that no single one can be carried off. He has likewise found that a wall, whose foundation is stone, though perhaps the stones rose no more than a foot, or a foot and a half high, having the upper part finished with feal, or of alternate layers of stone and feal, if the dimensions are the same as if it were composed entirely of feal, is probably more durable than any other kind of fence composed wholly of either of these materials.

At the foot of the wall or dyke, on either side is dug a small ditch about a foot and a half, or two feet deep, leaving a ledget of a few inches broad on each side, that the dyke may not be undermined by the crumbling down of the loose earth into the ditch. "These ditches," he says, "not only help to give the dyke an additional

PL.LXIII. 8°

WALL & EARTH FENCES.



height, and keep its foundation dry, but are also of use to prevent cattle from coming close to it, and rubbing upon it or tearing it down with their horns, which they are very apt to do if this precaution be omitted.

In respect to dry stone dykes, or walls, he observes, that "if you live in a country where good free-stone can be easily got, and lime can be procured at a moderate price, a dyke built of these materials will be little less durable than a hedge; although, in general, it will neither be so cheap nor so agreeable. But that dry stone dykes, unless built of the finest quarried stone, are of such a perishable nature, as to be scarcely ever worth the expense of rearing; unless the field that you would wish to inclose has plenty of stones upon it itself, which must be carried off from its surface before the field can be improved. In such a situation," he says, "a man may in some measure be excused if he should be tempted to put the stones into dykes; because the carriage of these materials may be said to cost him nothing, and he might perhaps be at a loss how to dispose of them in any other manner. But in all other circumstances he apprehends it is very bad œconomy to rear fences of this kind, as earthern or feal dykes can always be built at about one-fourth part of the expense that these would cost, will answer all purposes equally well, and if carefully built may be kept in repair for any number of years at a very small expense."

It is likewise suggested, that by having the joints in the fences bound in all directions, the whole is rendered more firm and compact than it could be made in any other way, and at the same time more readily formed. And that as the chief inconveniences to which they are exposed are those of their being liable to be torn or rubbed down by cattle, and to moulder away by the effects of frost and the action of the air, it might often be advantageous to set the banks with ivy, sweet-briar, furze, or some such kinds of plants, in order to protect them.

As earthern walls, or fences of that nature, can be formed in most situations in the way that has been described, at the expense of three-halfpence, or two-pence a yard, they seem well calculated for inclosing where cheapness is the primary object.

Different sorts of fences of these several kinds are shown in plate LXIII. in which fig. 1. represents a common stone wall coped with different sorts of materials. At *a* the coping is formed with brick, and at *b* with sod or turf. And fig. 2. exhibits the front of a brick wall, and also a wall formed wholly of turf: *a* the brick wall; *b* the turf wall. Fig. 3. displays walls constructed of different sorts of substances in combination: *a* is a turf and stone wall, *b* a mud and straw wall. Fig. 4. affords a view of a frame for constructing mud walls, and a dyke wall: *a* the mud wall frame, *b* a galloway dyke or wall. Fig. 5. shows a simple dyke or ditch fence; the quicks are put in behind the earth thrown up, and protected by a dead hedge behind them. Fig. 6. shows the double ditch, the earth taken out being formed into a bank in the middle. Quicks may be planted on one or both sides of the banks, according to circumstances, and protected by hedges when necessary. And fig. 7. is a sunk fence

faced with stone. When faced with turf this sort of fence should have a slanting form.

Figs. 8. 9. 10. and 11. represent the manner of forming earthen fences, so as to prevent their crumbling down and being destroyed. It is recommended by Dr. Anderson. Fig. 8. is a perpendicular section of it. Fig. 9. is a side view, and fig. 10. a perpendicular view of each row of turfs as it lies in the fence. The mode of construction is this: a long rut *x x x x* fig. 10. is made with the spade along each side, with the back to where the fence is to be, so as to form the cut of the turf slanting outward, as at fig. 8. and 11.: another rut *a z* fig. 10. is then made parallel to the former, at the distance of the length of the turf *a* from it, with the face to the fence, so as to slope inward as at R, fig. 11. in order that the first row of turf may be raised with facility: it is then cut into sods of proper breadth, as at dotted lines *a* fig. 10. which being raised by the spade are laid into the fence with the grassy side undermost, as at *a* figs. 8. 9. and 10.: the other side being finished in the same way, the upper surface of the whole course is pared smooth, and clapped down with the back of the space for the reception of the next course: another row of turf *b z* fig. 10. is then marked off to the distance of the breadth of that at *b*, figs. 8 and 10. from the former, with the face towards the fence; and the through band turf B on the opposite side being first lightly laid, this is put across the ends of them lengthways, so as to form a side band *b*, figs. 9. and 10.: another rut *c z* is then formed at the distance of the length of the turf *e* from the former; but before it is raised, it is necessary to draw a rut in the line *b z*, with the back towards the fence, which gives it the form BAC, fig. 11. leaving a small triangular piece at S; so that when put up in the fence it has the position shown at BAC, and thus permits the opposite side band O to join intimately with it, which would otherwise have projected outward above as to D, so that the turf O could not have joined it closely, but have left a triangular opening in the middle, and thus rendered the fence less compact and solid. The work is to proceed in this manner, always rutting the through band rows of turf in both ends, but the side bands only on one side, beginning every course with those that cross the fence. The top course should be cut a little longer than those below it, and placed with the grassy side uppermost, so as to project a little, as at *L l* fig. 8. or, what is perhaps better, set on the edge, as in fig. 11.; as by this means the water is not only better thrown off, but the fence rendered more secure from cattle and the effects of wind. At the foot of the fence a ditch, as XX fig. 8. should be dug on each side, a foot and a half or two feet deep, a ledgelet being left a few inches in breadth, to guard against the effects of crumbling, keep the foundation dry, and prevent the intrusion of cattle.

Walls constructed in many of the modes that have been mentioned above, may frequently be made either more durable, or more ornamental, by being *dashed*, *lipped*, or *harled* with lime.

For a limited number of years, where stones can be easily procured, there can probably be little doubt but that walled fences may

be preferable to most other kinds, as they can be readily repaired in cases of accident, and keep cattle very secure. Where the land is poor, too, with much exposure to violent and desolating winds, so that live hedges cannot be easily raised, they may be found the most advantageous sort of fences.

PALINGS.—Fences constructed of timber can in but very few situations be advantageously employed for the purpose of inclosing land, except for parks and pleasure-grounds, or they may be formed of the coarser sorts of wood, and placed on the banks or sides of ditches, for the protection of young thorn or other hedges, and for the dividing of fields, as occupying little room, and other uses of the same nature.

The most cheap and common sort of paling made use of for the inclosing of farms is that in which two, three, and sometimes four long pieces of timber, but little dressed or prepared, are nailed in a longitudinal direction to upright posts of different thicknesses, according to circumstances, firmly set or drove into the ground. In some cases these fences are rendered more firm, strong, and durable, by having triangular pieces of sawn wood fastened lengthways upon the tops of the posts, by nails or wooden pins, with one of the edges upwards so as to convey away and cover them from being injured by the effects of water. This is a much better and cheaper mode than that of making holes in the top pieces, in order to admit the heads of the posts to pass through them; or than that of inserting them into the posts by means of mortises made in them.

Where there are coppices of young wood, either of fir, ash, or other kinds, fences of this nature may be formed at very small expense by the trimmings from them, as the work may be performed by any common ingenious labourer. Care should, however, always be taken that the horizontal pieces be not fixed at too great distances from each other, as where this is not sufficiently attended to, much inconvenience may be sustained by animals creeping between them.

But a better sort of farm paling may be constructed by having the posts hewn, and considerably thicker, and mortises formed in them to receive the longitudinal pieces. This, however, though certainly a more neat, and probably, in most cases, a more lasting kind of fence, is attended with much more expense. As the cutting of mortises is liable to weaken the posts, and by admitting water to decay them, it has been suggested to attach the cross or horizontal pieces to them by means of strong iron staples. Iron is, however, very subject to be destroyed by the action of air and moisture, except it be kept constantly well covered with paint, which is not only troublesome, but expensive.

There are still other kinds of palings that may be employed as fences in particular cases. Where such pieces of timber as are proper for rails are scarce, a good fence may be formed by only having one nailed at the top, and another at the bottom, to the upright post; or, indeed, by having only one at the top, the middle being filled up by nailing short thin upright pieces upon them,

at the distance of six or eight inches from each other, being in the latter way left longer, and drove well into the ground. The slips or laths in this sort of fence, as they are but short, may be easily procured from such kinds of wood as are the least valuable, and which cannot be used for many other purposes. Such, for instance, as may have been procured from the lopping of timber-trees, or the thinning of plantations; but in all cases they should be well seasoned before they are made use of, as green wood not only soon decays, but is quickly torn by the action of the sun.

From the closeness of this sort of fence, it seems well calculated for such inclosures as are to be kept in a state of pasturage, and where young quick hedges of any kind are to be protected and kept from the cropping of cattle.

A close kind of fence may likewise be made by nailing upon any of the above framings, either in a longitudinal or upright direction, pieces of fir, or any kind of timber, roughly sawn into pales of about an inch in thickness, and of such breadths as the timber will allow, so as slightly to lap over the edges of each other. When nailed on lengthwise, the upright posts must be placed in the ground, at suitable distances for the length of the coarse pales or shingles.

There is a kind of moveable paling-fence that may frequently be of utility in dividing inclosures or confining sheep and other sorts of animals while they are feeding on different sorts of vegetable productions, which would be much injured, and not fed off so œconomically, if they were not confined by some such means. This is the hurdle-fence, which may be made of any small sort of wood, but such kinds as are the lightest in proportion to their size should be preferred. On this account the willow, the poplar, and the alder, when well dried and seasoned, may be highly useful for the purpose of framed hurdles. Good hurdles may likewise be made by wattling young hazle plants, or others of a similar kind, between upright standards. These are not, however, so neat as the former, but in general are much cheaper. Where the framed hurdle is made use of, it is rendered considerably more ready and convenient, as well as more durable, though a little more expensive, by having the parts that are to be placed in the ground pointed with iron. Where this is done a hurdle-fence can be set down in a very short time. In some cases it might likewise be of great utility to have small iron loops and gudgeons at the upper parts, so as that the whole fence might be connected from one end to the other by them.

Various fences of these kinds may be seen in plate LXIV. in which fig. 1. represents two different sorts of paling fences; *a*, a coarse nailed, undressed, sawn paling; *b*, a jointed, horizontal, dressed paling fence: and fig. 2. exhibits two other sorts of paling fences: *a*, an upright light lath paling, supported by rests as necessary; *b*, a fir paling of the horizontal kind, made from the thinnings of trees of that kind, the lateral branches being trimmed off two inches from the stems. Fig. 3. shows two palings of another kind: *a*, an upright fir paling with the branches left as in *b*,

PAILING FENCES.

Fig. 1.

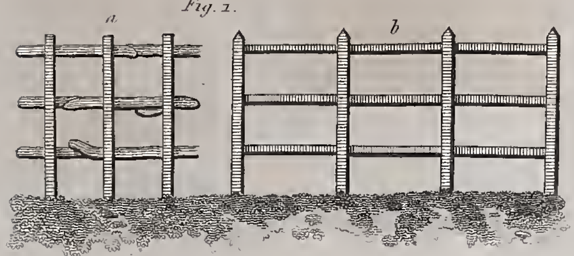


Fig. 2.

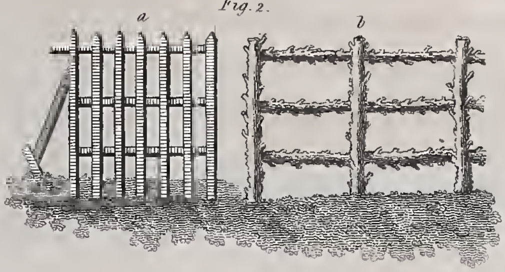


Fig. 3.

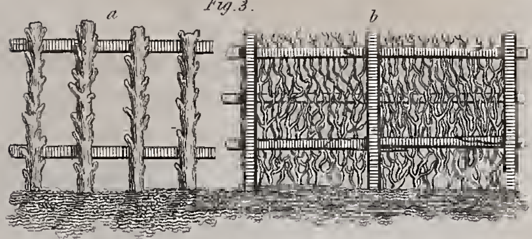


Fig. 4.

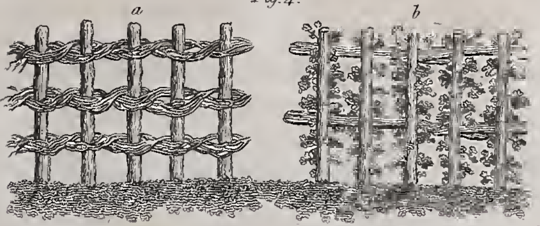


Fig. 5.

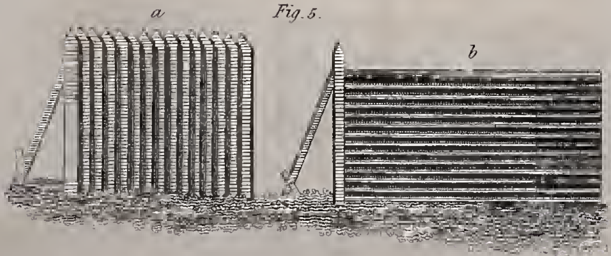


Fig. 6.

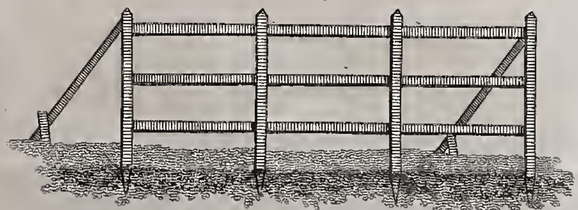


Fig. 7.

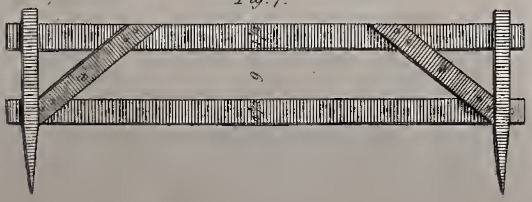


Fig. 8.

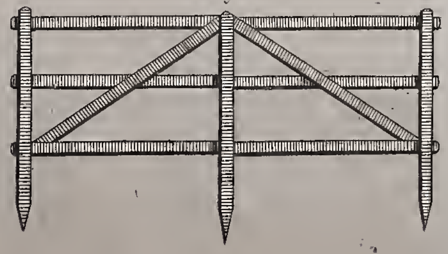


fig. 1. *b* an open nailed paling fence warped with thorns: and fig. 4. contains two other sorts of fences: *a*, an osier or willow fence wattled together in three different parts; *b*, a paling fence from growing trees.

Fig. 5. exhibits two sorts of close paling: *a*, upright or park-paling; *b*, a lath horizontal paling. These are very useful kinds of fences where closeness is required.

Fig. 6. is a moveable or hurdle-fence. And fig. 7. represents a lamb-hurdle used in Lincolnshire, for preventing the lambs falling into the ditches of the pastures in stormy seasons. The spaces between the rails are closed by tarpaulin. Mr. Young suggests, that slit deals may answer, being held in their places by the braces *aa*, one of which being moveable, the other fixed with nuts on the rivets, so as to admit the board to take out accasionally. Fig. 8. is the common hurdle, which may be used as a fence in many situations with great convenience, as well as for protecting young quickset hedges.

In the erecting of all sorts of paling-fences, but especially such as are of the more expensive kinds, as those for parks and pleasure-grounds, great attention should be paid to having the posts of sufficient length, in order that they may be set to a good depth in the ground; as, without this be done, and the post holes well rammed up, they are very liable to be pushed and blown down, or become irregular in their appearance. The depths to which the posts ought to be placed into the ground must vary according to the nature of the soil, and the height and kind of paling, but where it is close or of much height, from two to three feet is, in general, little enough. Such a season should always be chosen for putting down the posts, as that they may be well rammed up at the time. In wet seasons this sort of business cannot, by any means, be effectually performed; a rather dry period is to be preferred. As something of the nature of putrid fermentation is apt to take place about the part where the posts come above the ground, by which the wood is soon mouldered and decayed away, it is necessary to guard against it as much as possible, by preparing them in some way or other. From charcoal being known to be highly indestructible, posts have been charred at the bottoms with this view; and where the operation is well and cautiously performed it may be a very useful method. The application of tar and different sorts of oil paints has, likewise, been made with the same intention; but as all such applications are soon decomposed when placed in contact with the moist earth, they can of course only resist the decay for a very short time. Of these substances, those which penetrate the wood the most are always to be preferred, which should be applied when the wood is perfectly dry and free from moisture, and the posts be left for some time before they are put into the ground.

Where posts can be had with the bark wholly upon them, especially if they have been cut at a proper season, no application of any sort will be necessary, as this covering is found to resist decay much longer than any artificial application of the nature of paint.

Much advantage may often be gained in preventing the decay of posts, by the ground on which they are placed being raised into a

sort of sharp ridge, so that the water may never be suffered to stagnate about them, the holes being made up rather higher than any other part, a circumstance which is seldom much regarded.

For the covering of farm palings, tar, as being a cheap substance, when good and well boiled with a little ochre for the purpose of thickening and giving it a body, is probably the most useful general application. It should always be laid on in as hot a state as possible, and the wood at the time be as free as possible from moisture. Coal oil, if it could be rendered of a rather more thick consistence, might probably be employed for these coarse purposes with great advantage; but when used in the form of paint, it is liable to become flaky, and peel off.

HEDGES.—In the raising of quick-hedges, the planter should always have attention to the nature of the soil and the situation of the ground, and of course adapt his plants to them; which may, in most instances, be done by attending to the growth of such plants as are already on the land; and he may employ either one, or a mixture of different kinds of plants for the purpose; but the latter practice is not, in general, to be recommended. On dry and tolerably good soils, especially for outside fences, the white and black-thorns ought always to be preferred. The latter is not, however, so certain a grower, except the ground have a rich and rather dry friable mould; but it is more lasting, and not so liable to be cropped by cattle.

Some practical planters think, however, that black-thorns should never be put in, except upon very cold and wet land, where white-thorns will not grow; and that crab-sets are even in these cases much better; as they grow slow, make a sorry, weak fence, and are sure to run and spread out into the inclosures.

In low situations, where there is much surface water, and where the soil is rather loose and retentive of moisture, the farmer may have recourse to plants of the willow tribe for the forming of his hedges, as under such circumstances they grow not only with great rapidity and vigour, but are capable of being converted to a great variety of useful purposes.

They do not, however, make a very good fence, and are sometimes apt to prove injurious to cattle, by their cropping and eating the young shoots too freely. Young cattle have been known to be killed by them. Where cattle are to be pastured, it is therefore better to have recourse to white-thorns, as they may be very well raised upon such soils, by care being taken in their planting to raise the ground where they are placed with two or three table turfs.

On those dry and sandy banks where there is not sufficient depth of soil for the support of the thorn, furze makes a tolerable fence, provided it be not suffered to grow too high, and be clipped or cut at proper seasons.

But on such banks as are liable to be carried away by the washings of streams of water, the alder and the willow may be planted with considerable advantage, as by throwing out a great number of branches from their roots, they afford great support to such banks.

And in very exposed and elevated situations, the beech and the

birch will probably be found the most proper plants for raising live-hedges with; as experience has shown that, by proper attention, in such places they form good fences in a short time.

Wherever a mixture of different sorts of plants is employed in making a hedge, such should always be chosen as are capable of thriving well on the same kind of soil and in the same kind of situation, as well as of growing with nearly equal degrees of strength; for without this a very imperfect fence must be formed; as while some of the plants are getting forward with great vigour and luxuriance, others will proceed in a very feeble and sickly manner, from being checked by the shade and obstruction caused by the larger ones, thus rendering it thin, uneven, and defective. Beside, some sorts of plants, by being blended with others in the making of live-hedges, have a disposition to smother and destroy them, by too closely uniting with, or intwining round them. Honey-suckles, brambles, and many other plants of the same nature, have constantly a tendency to produce such effects in hedges.

Before any kind of quick-hedge is planted, the line of ground on which it is to be placed should be ploughed or dug up, and undergo such a degree of preparation as will render the soil, of whatever kind it may be, perfectly mellow and friable, as well as less disposed to throw up weeds; as by such means the fibres of the plants will not only be more readily enabled to shoot out and establish themselves in the ground, but the plants be less liable to injury from the effects of weeds; from both of which causes young hedges often suffer greatly when the plants are put in in the common mode, the ground being scarcely in any way prepared for their reception. In some instances, perhaps, as where the soil is extremely stiff and tenacious, such kinds of manures as have a tendency to lessen the cohesion may be of much utility; but in other cases they do not seem to be so particularly necessary.

After the ground has been thus well broke down and rendered suitable for the young plants, the next thing is to put them in. This should always be done in the early part of autumn, in order that the earth or mould may fall down and get well fixed about their root fibres before the winter frosts set in. When planted in early spring, which is frequently the practice, we have not found them to thrive by any means so well, and to be much more liable to injury from the heats of the spring and summer, as they are seldom well fixed in the soil before these take place. Beside, it frequently happens, especially in the more northern situations, that the frosts continue so long as to protract their being planted out to a period when they can hardly be expected to succeed.

In the first mode, if sufficient care has been taken not to injure the roots of the plants in trimming and taking them up, they succeed with great certainty, and make a very rapid growth, frequently becoming a hedge a year or two sooner than when treated in the common method.

It has been most commonly recommended to take the plants for the purpose of making quick-thorn hedges with, from the most poor and worst kinds of soil, as by such means it has been thought

that they would grow more vigorously when removed into such as are of a richer quality. It must, however, be considered, that such plants as have been stunted in their growth, or grown in a feeble and sickly manner, are not only a long time in recovering themselves, but at last seldom thrive so vigorously as those which have been procured from a rich situation. It is observed by an able writer, that "he has found, from reiterated experiment, that a strong and vigorous plant, which has grown up quickly, and arrived at considerable magnitude in a very short time, never fails to grow better after transplanting, than another of the same size that is older and more stinted in its growth, whether the soil in which they are planted be rich or poor: so that, instead of recommending a poor hungry soil for a nursery, he would, in all cases, wish to set apart for this purpose the richest and most fertile spot that could be found; and, in the choice of plants, would always prefer the youngest and most healthy to such as were older, if of an equal size. That he speaks here from experience, and therefore does it without the smallest doubt or hesitation: being certain that future observations will confirm the justness of the remarks."

As it has been found, by various practical trials in forming white-thorn hedges, that such plants succeed the best as possess the greatest number of fibrous roots about the bottom of their stems, it is a matter of importance to adopt such methods as tend to produce such effects while they are in the nursery. This may, probably, be much effected by transplanting at an early period, as the first or second year, and lopping off all such roots as have a tendency to strike directly downwards, or to extend too much in a lateral direction, the plants being placed in a very rich soil, and kept at a good distance from each other, in order that they may not only grow strongly, but that the ground between them may be rendered sufficiently clean. It is remarked by the ingenious author just mentioned, "that in the winter succeeding the time the thorns have been transplanted, the earth between the rows ought to be dug over with the spade, taking care to go very close to the rows, and to work with a very sharp-edged tool, the operator always taking care to force his spade straight down, with the back of the spade towards the thorns on each side of the row, as close to it as possible, so as to cut the greatest part of the lateral roots as near the body of the plants as may be, which will tend to make them branch out into still more numerous ramifications. And if the ground be dug every winter afterwards, keeping at a little greater distance from the plant at each successive digging, the roots will be kept at all times so short, and the ramifications will be so numerous near the stem, that when they shall be lifted to be put into the hedge, they will not fail to be provided with such an abundance of mouths to imbibe nourishment with, as to be in no danger of suffering much by that operation. If, continues he, "the soil of the nursery be sufficiently rich, and if the thorns have been transplanted while young, and early in winter, they will rush up chiefly in height, and send out but few lateral branches; which is a thing much to be wished for in a nursery; therefore care ought to be taken, when they are first transplanted,

not to bruise or injure the stem of the plant, nor, on almost any account, to cut it over, unless the stem was before sickly and stinted. Neither ought the upright shoots to be in any case shortened while in the nursery; but to facilitate the operations between the rows, any straggling side-branches that may spring out ought to be cut off by the knife, or shears, at the beginning of winter.

"In every situation it will," he says, "be proper that the earth between the rows be stirred the first winter *by the spade;* but if the nursery is of great extent, it may be afterwards done by means of the plough, with the utmost facility."

Between the rows of quicks, where such large spaces are left, various kinds of garden crops of the dwarf sort might be cultivated to advantage; such as turnips, spinach, and onions.

In collecting plants for forming thorn hedges, it has been generally the custom to prefer such as are very young and small; but it is probably a much better, as well as more expeditious practise, where they can be procured, to have them much older and larger; as where the plants are of a considerable size, the hedge is not only much more readily formed, but the plants far less liable to be injured by the severity of the winter season, or the heat of the summer, and require a great deal less nursing and protection than where very young plants are made use of. In using plants of a large size, care should, however, constantly be taken to have their roots preserved as much as possible.

It has been suggested by an intelligent farmer that the white-thorn should, on no consideration, be *less* than four years old when it is planted; if younger, it is unable to encounter the drought of the first summer. An intermixture of holly in white-thorn fences is at once ornamental and useful: the young plants should be carefully weeded and moulded up every spring, for the first three or four years. They should also be cut down the third or fourth year within four inches of the bank, in order that they may throw out lateral shoots, and thus become thick at the bottom. Too much care can scarcely be bestowed in cherishing young fences, in preserving them against the nibbling of stock, against the severity of drought, and the double injury which weeds commit, by choking them with their own luxuriant growth, and by robbing them of their necessary nourishment.

But whatever sort or size of plants be employed, it is a necessary circumstance to have all such as are to be planted in the same fence as nearly of the same vigour of growth and dimensions as possible; as by proper attention in this respect the fence will be less in danger of having gaps and thin places formed in it, which must otherwise be the case from the inequality of the growth of different sized plants. Besides, by properly sorting them, the farmer may be more enabled to adapt them to the particular circumstances of the soil and situation of his land.

In preparing the quicks for planting, whatever the age or size may be, the roots should be but very little touched by the knife, as it is always of advantage to the growth of the plants to have as many root-fibres as possible remaining. Some part of the tops of such

plants should, however, constantly be cut away, as from the injury which their roots sustain in transplanting, they can seldom or ever supply a sufficiency of nourishment to preserve them from decay; in the older sorts of plants more freedom in cutting may, however, be used than in such as are young.

The methods of planting live edges vary considerably in different districts, according to the customs and kinds of plants that are employed. In some cases the plants are placed in a horizontal direction upon sods turned mould-side upwards, in the face of *ditch-banks*, *mounds*, or *walls*, and covered up so as to have but a few inches of the plants without, in order that not more than one or two vigorous shoots may be thrown out by each. In this mode of planting, a good bed of mould should be made for the reception of the roots of the plants, as well as covering them well up, as by this means they will be found to thrive much better.

It is remarked, on the authority of much experience, that "the proper method of planting this kind of hedge is, first, to turn up a little of the earth from the place where the ditch is to be made, and lay it upon the bank reversed, so as to form a bed for the plant about two inches thick above the solid ground. Upon this, the thorns should be laid nearly in a horizontal position, but inclining a little upward in the point, and having the ends of the stems just equal with the face of the bank, or projecting beyond it very little, not more than half an inch. By this means, it is thought, the plants will send out only one or two shoots each, which will be the more vigorous, as there are so few of them. Where a greater number of shoots are sent out in any plant, it will be proper," it is said, "to prune away all the supernumeraries the first winter after planting, cutting them with a knife close by the stem from which they spring: for it is the largeness of these original stamina of the hedge that will afterwards constitute its strength, and not the number of small ramifications, as is too generally imagined. If the shoots are numerous, they never acquire such a degree of strength as when there are fewer of them. But an easier way still is, to rub off the supernumerary buds as soon as they begin to shoot in the spring. The plants being thus regularly laid, should have their roots immediately covered with the best mould taken from the surface of the ditch; and the workmen should take care to keep that good mould well back upon the bank and rather behind the roots, leaving the breast of the bank to be made up by the less fertile earth taken from the bottom of the ditch. By this means the roots will have all the good earth about them, in which they will spread with freedom, and draw from it abundant nourishment; and the bad earth, which forms the breast of the bank will produce much fewer weeds there than the good earth would have done, if it had been kept near the surface.

As the hawthorn is, however, known to be impatient of much wet resting near the roots, it ought never to be planted by the sides or on the edges of ditches that have much stagnant water in them. The common method of planting quicks on the borders of ditches, near to the banks, is, indeed, *in most cases* and situations, a bad practice; for whatever the nature of the soil may be, from the effects of the

weather, and various other causes, the mould on their sides is constantly removing itself, and leaving the roots of the plants exposed and without support.

In some districts the banks on which the quicks are planted are made six feet wide at the bottom, three and a half at the top, and two feet in height. Some planters likewise prefer a ditch on each side, about three feet wide and two feet deep, the slides being made in a sloping direction, and the bottoms not wider than six inches; while others only make one ditch, the earth on the opposite side being pared off to a slope. Some prefer earth mounds, planting the quicks upon a turned sod, six inches high at their basis, and on the edges of the ditches out of which they are raised. Where this mode is followed, it would, probably, be better to plant three sods high, with the thickness of two surface sods put under their roots. In this way the surface soil is in most cases doubled, and in the thinner sorts of soils nearly trebled, and a thick bed of the best earth is formed for the quicks to grow in.

Where young quicks are to be planted, is has also been recommended that the bank should be sufficiently wide; for instance, not less than four feet wide at the top; that room may be allowed for planting two rows, at two feet or more asunder, on the flat surface of the bank; care being taken that the roots be inserted in the best mould, and that the sides be sloped in such a manner as effectually to prevent their crumbling down, with a ditch on each side. And in order to prevent the depredations of cattle, thorns may be placed loosely in the ditches. This method saves the heavy expense of posts and rails, or dead hedges, as cattle cannot stand nearer the stems of the quicks than six feet, which is sufficient to prevent their being destroyed. Mr. Billingsley has not, however, found this plan to succeed well in Somersetshire.

In making quickset hedges, Mr. Middleton likewise thinks it would probably be an improvement on the practice which has been generally followed, to put two rows of quicks in, at about a foot and a half or two feet from each other, which on growing up might be cut alternately every five or six years. The cut wood being by this means ten or twelve years old, and that left for a fence five or six; which would be sufficient for a fence as well as for the protection of the young shoots on one side from being cropped by cattle, while on the other they might be guarded by dead thorns thrown into the ditch. By this plan, hedges would, he supposes, become extremely profitable to the farmers. "But the method," says he, "above all others the best, if it should be found to succeed, as it probably may, on a moist soil in a moist climate, is the grubbing of thorns five or six feet high, in copses, &c. trimming the roots and planting them closely on one spit of the best mould laid on the turf. This should be taken from where the ditches are intended to be made, and chopped well to pieces. Then raise a bank on their roots round their stems at least three feet high, and cut their tops level, two feet above the bank."

Of the advantage of this mode of making a quick fence at once, we are in some measure convinced by the trials we have made. It is

necessary, however, to the complete success of the plan, that the quicks be taken up with care, be planted at a proper season, and have a considerable depth of fine mould for the fibres of the roots to shoot into. A mixture of nearly equal parts of the scrapings of roads and good rich mould we have found them to grow by much the best in. If the season be dry for some time after they have been planted, it will sometimes be necessary to water the earth frequently about their roots.

Where the plants are put in upon banks, of whatever kind they may be, they should always be placed sufficiently back, in order to prevent their being carried away by the crumbling down of the sides; and that they may be kept free from weeds, and the mould be better laid to them, instead of the common distance of four or five inches, it should probably be seldom less than ten or twelve.

The large banks made by having double ditches, are not perhaps to be adopted but in very wet situations, as they take up a great deal of land without affording any advantage over the simple ditch. One ditch properly made will be enabled to carry off the water equally as well as two; nor is a double row of plants to be had recourse to but in particular exposed places; as a single row, when attention is paid in putting them into the bank, will be quite sufficient for the forming of a good hedge.

High banks, in whatever manner they may be made, seem to be necessary only in such soils as are cold, wet, and subject to the stagnation of moisture at particular seasons.

Where ditches on the sides are required, they should constantly be made to slope down in such a way as not to be wider than six inches at the bottom, as by this means the cattle will, in some measure, be prevented from walking in them, and eating the young shoots. Care should likewise be taken, in performing this business, that none of the stiff bad earth from the bottom of the ditches be thrown into the middle of the bank where the quicks are to be set, as it would retard their growth very materially, and, in some cases, perhaps, entirely destroy them.

In other instances the quicks are planted on the plain surface without any bank being raised, a furrow being formed with a common plough, or a spit of earth dug out, in which the plants are placed in rather a slanting direction lengthways of the hedge, as well as against the upright side of the furrow or trench, at the distance of about four or five inches from each other, covering them with a little of the mould or earth that has been turned up on the other side, and treading it closely to their roots. The rest of the loose mould is generally, in this method of planting, afterwards laid close to the planks by means of a spade.

Sometimes they are planted in the middle of the furrow or trench, the earth being brought close to them by the feet, and the raking of it up on each side. There are several other varieties in the modes of planting, but which, as they differ only in the manner of preparing the trench or furrow, and bringing the mould to the roots of the plants, do not require to be particularly described.

In the last method of planting, the young quicks are, in some

places, put into holes made by a kind of dibble; but this is a practice that cannot be recommended, as the roots of the plants are not only too much confined, but the water, especially in retentive stiff soils, is liable to stagnate in the holes, and prevent them from taking root quickly, by which they are often wholly destroyed.

The method of planting quick hedges upon the surface of the ground without much elevation, seems most suited to the drier kinds of soil, or such as would be rendered too dry for their growth by having ditches cut on the sides. But even in this way of proceeding, some kind of ridge, or elevation, should be preserved, that the rain water may not injure the young plants by stagnating too much about their roots.

In planting the quicks where the ground is raised, Mr. Billingsley advises a trench to be cut in the middle of the bank, into which the sets are to be put at the distance of about three inches from each other, with their heads a little inclining. The roots must then be covered with a little of the best mould, and afterwards the whole trench be filled up with rotten dung or compost, only strewing some more good mould on the surface. But we are assured on the authority of much experience and observation, that it is infinitely better to place them five or six inches apart; and that it is seldom necessary to use dung or compost to the roots of them where the soil is tolerably good, and care is taken to apply it well to the roots, as it is apt to breed insects, which are very injurious to the roots of the quicks.

The distances recommended above, may, however, answer very well where the plants are small, and the situation exposed; but six or seven inches is better where the plants are of a good size, and the situation not too open. Indeed, some advise them to be planted still wider, as nine inches; and on good land, as much as a foot. Thick planting is, however, in general, to be preferred, especially in exposed places; as hedges, under such circumstances, for the most part thrive the best, especially for a few years; and they may afterwards be prevented from being liable to choke and destroy each other, by proper thinning. Where fencing wood is not easily procured, it may also sometimes be a good practice to plant the quicks both in the face and top of the bank.

In exposed situations it will always be necessary to shelter and protect the young plants by means of some sort of dead fence, such as dead hedges, high banks, low walls, rails, or belts of planting. Where the first is employed, it should be made about four inches distant from the outer edges of the bank. The hedges for this purpose are mostly about two feet and a half high, and made of wreath, or brush-wood, with a sufficient number of stakes. This mode is not only much cheaper than that of posts and rails, but likewise considerably better, on account of the shelter and warmth which it affords to the young plants.

In cold exposed situations, Mr. Billingsley thinks that *two sets* of dead fences may sometimes be required for bringing the quicks to maturity; the expense of which he calculates at 8s. 7d. per rope.

It is observed that "one waggon load of writh will cost 17s. 6d. and make about fifteen rope of single hedge. And that the old

wood will pay for sundry repairs of the hedges, arising from different accidents.

In low wet situations it would probably be the cheapest method to have recourse to short willow stakes, which might be put into the edge of the bank in a sloping direction outwards, and to be bound together by means of an eddering at the top. In this way the quicks would soon be protected by means of a living fence. In the Devonshire mode of planting on a high bank, something of this sort is practised for protecting the young quicks on each side.

High banks are sometimes raised with sods and earth in exposed situations for the purpose of protecting young plants. Where stones are plentiful, and the sods laid on the surface, walls about two feet high are raised for the same purpose. Rails can be used where protection from cattle is only required. If belts of planting be had recourse to with this intention, the most hardy sorts of trees or shrubs should be placed on the outside, and such as grow with more difficulty within them.

These fences are frequently prevented from succeeding so well as they might otherwise do, especially where the quicks are young, by the bottoms being neglected and not kept sufficiently clean. They should be well weeded and hoed as often as is necessary, and every sort of rubbish be carefully removed from about their roots and stems. This may be performed in the most easy and beneficial manner, by first loosening the earth on the sides of the plants by means of a sort of spud or three-pronged fork, as the roots are thus not so liable to be injured, while the weeds are more readily removed. In young hedges, this business should always be done as early as possible in the spring, in order that the weeds may be prevented from seeding, as well as getting too great a head. In the cleaning of hedges, when situated in the banks of ditches, it is a common practice to pare the surface off thinly by a spade; but which, though it renders it clean for the time, not only exposes the banks more to the mouldering effects of the air and frosts, but in time so reduces them that the roots of the plants are left exposed, and the ditches so choked up as to prevent the water from getting readily away.

The cropping of sheep and cattle ought also constantly to be well guarded against; but where this has happened, the bruised shoot should always be cut down within an inch or two of the ground. The mould should, likewise, be loosened and drawn up a little to the roots of the plants; by which they are made to grow not only more vigorously, but to send out more numerous shoots.

All the operations for the above purposes should, probably, be performed much more frequently than is the common practice among farmers; as by such means the general growth of the hedges will not only be encouraged, but more numerous shoots be sent off from the bottom stems, and thus render them thicker.

Different fences of the live-hedge kind, as well as the modes of forming and planting them, are shown in plate LXV. in which fig. 1. represents a white thorn hedge, with the leaves upon it, so cut and trained as to leave it in the ridge form, or broad at bottom and

Pl. LXV. 8.º

HEDGE FENCES.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

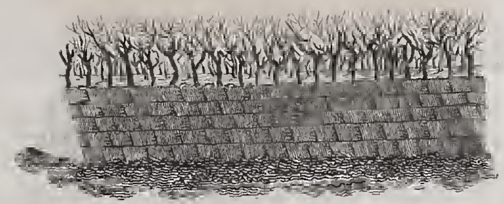
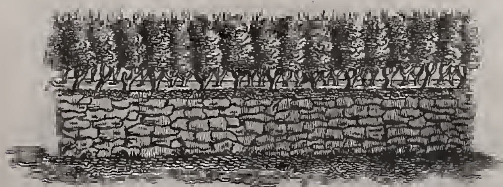


Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.



narrow at the top. And fig. 2. is the representation of a hedge in the face of a bank, as described by Mr. Somerville.

Fig. 3. exhibits a hedge at the bottom of the bank. Fig. 4. is a representation of the Devonshire fence. Fig. 5. represents a hedge fence placed on the top of the bank.

Fig. 6. shows another mode of planting a hedge upon the top of the bank, with the management of the young plants by a protection of willow-hedge, raised by setting the stakes. Fig. 7. is a hedge with a wall. And

Fig, 8. shows a hedge on the wall.

In regard to the propriety of planting timber trees in hedge-rows, there is some difference of opinion; we apprehend, however, that it cannot in general be admitted to any very great extent, though it ought not probably to be totally neglected. When planted in this way, the droppings of large trees do not only frequently destroy the young thorn-plants, and thereby cause holes or vacancies in the hedges, but considerably injure different sorts of crops, especially those of the corn and grass kinds.

Where hedge-row planting is, however, wholly disregarded, there is a nakedness, as well as wildness of prospect, which is highly disgusting to the eye of the traveller. Besides, as in this way timber trees are raised with but little expense or trouble, there would seem to be considerable loss to the proprietors of land, as well as farmers, in not paying some attention to such methods of raising useful and necessary timber.

When this method is followed, and for planting in the angles, corners, and other waste spots of fields, the Scotch fir, the beech, larch, sycamore, and birch, as being hardy trees, are the most proper. The ash may, likewise, be made use of in some cases without any inconvenience. It is, however, thought by some that timber is raised at a greater expense in this way than any other, when all the injury they do is taken into the account.

The common custom of cutting and clipping young thorn and other quick hedges every year, however advantageous it may be considered in point of the appearance of the fence, is highly prejudicial to the growth of the quicks or other plants, keeping them small and weak in the stems, and rendering the hedges as they grow old open at the bottoms. On the contrary, those that are left to themselves become strong in the stems, and have large side branches, which, by interweaving with one another, render the hedge thick and impenetrable. Those that are cut at proper intervals, as about every seven or eight years, have generally a considerable superiority over those which have been clipped from the time they were first planted. Besides, there is a considerable saving of labour, and the hedges are far more profitable.

When pruning is necessary, it may be performed in a neat and expeditious manner by means of a pair of pruning shears; the best sort of which are those constructed with a strong sharp blade, about six or eight inches in length, moving between two pieces of iron, with square edges as cheeks. The handles should be a good length, in order to give the operator sufficient command in cutting the upper

parts of the hedge, and the higher one three or four inches longer than the lower. Some workmen, however, prefer for this purpose an instrument made somewhat in the form of a reaping-hook, and extremely sharp, to which is fixed a handle of about two feet or two feet and a half long. In the hands of an expert workman this, too, is a very good implement.

The time at which hedges are usually cut is the summer, which, from the state of vegetation, is evidently the most improper that can be chosen, as the plants by being cut while full of sap or juice cannot but be greatly injured. The most suitable period for this business would seem to be that of the latter part of autumn, when the growth of the plants is in a declining or the least vigorous state.

In respect to the manner of cutting them, various methods are adopted and practised; but that which seems to give them the most useful form, is by letting them have a kind of sloping or narrowing direction on both sides from the bottom to the top, as by such a mode the thickest part will be in the bottom, where it is most wanted. The reverse of this is, however, frequently the case in cut or clipped hedges.

For several years after a hedge has been planted, it should, probably undergo little cutting, except in the lateral branches that may spread out.

"It will appear evident" an experienced writer thinks "that if we wish to have a good hedge, either in respect of strength or closeness, it is of importance never to shorten the top shoots, at least while it is young; but it is always of use to prune the sides, cutting off all the lateral shoots with the scissars quite close to the upright stems, after the first year's growth. And if, after the growth of the second year, it should happen that too many shoots have sprung out at the top of the first year's shoots (which very frequently is the case), these supernumeraries should be cautiously pruned away with a knife; taking out all the strong upright-growing branches, excepting one for a stem; being always particularly careful to cut them away quite close to the stem from which they spring: for if this caution were," he says, "neglected, a greater number of shoots would spring out from the wound, and the malady be increased rather than diminished."

These circumstances being properly attended to, the hedge will, it is conceived, need no further care afterwards, but to be defended from cattle, kept free of weeds, and clipped in the sides once a-year for some time; care being always taken at each clipping to go as close to the last as can easily be done, especially towards the upper parts of the hedge; but towards the bottom, the shoots may be allowed to remain gradually a little longer, so as to make the side of the hedge to slope inwards a little above, which gives to the undertwigs a freshness they could not otherwise be made to attain. In first performing this operation, particular attention should be paid to clip it as near to the upright stems as possible; for, as the side branches must always extend a little further at every cutting, if this caution be neglected the lateral shanks will in time become naked, and disagreeable voids of course formed in the surface of the hedge.

By attending to these rules for a few years, he supposes the hedge, while it advances in height, will become as close in the sides as could be wished for; and that although the clipping of the sides should be discontinued after a short time, it will be in no danger of running into great disorder; for, as the vigour of the side shoots will have been much diminished by having been so frequently divided, none of them will afterwards advance to such a distance as to deform or hurt the hedge; so that, he thinks, the operation may be discontinued, unless in cases where great neatness is wanted.

In comparing quickset hedges with walled fences, Mr. Billingsley remarks, that "they are beautiful to the eye: and that if the climate, quality, and depth of soil, be such as to throw out a vigorous shoot, and minute attention be paid to them in their infancy, they are less expensive, and at the end of fourteen years will yield a sufficient produce when cut down and plashed to pay all the expenses incurred in the first making; and that this cutting may be repeated every twelve or fourteen years without injury to the stocks."

He also judiciously reminds the farmer, that the proper time for plashing his hedges is when the land is to be ploughed, or, if it be pasture, when the crop is to stand for hay. By taking advantage of the ground being in these situations, the mischief produced by cattle will be perfectly provided against.

In the management of old hedges, several different methods are employed. Where they become much stinted, from the badness of the soil in which they are planted, or other similar causes, the most ready and effectual mode of recovering them is probably to cut the plants of which they are composed down pretty close to the surface of the ground, in the latter end of autumn or the early part of the spring; afterwards keeping them perfectly free from weeds, and managing them in the way that has been directed above. And in the spring, when the young buds begin to appear, it is advised, by an experienced writer, to attend carefully to the stumps, in order to rub off all the buds, except one or two of the strongest, which are best placed for shoots; as where the whole number are suffered to remain and grow, they soon become weak and restricted in their growth, as in the former case. For want of due attention to this, hedges that have been several times cut over are frequently quite spoiled. Where the fields on the sides of hedges treated in this way are in a state of tillage, they are likewise constantly found to thrive better than where that is not the case, especially if they have been planted on the plain surface, or only on a slight bank.

In other instances, hedges, when they have had about eight or ten years' growth, are headed down to the height of two or three feet. This is, however, by no means a good practice, as in consequence of the young shoots springing from the tops of the stems, the lower parts of the hedge in a few years not only become thin, bare, and full of openings, many of the stems being dead, but, from their shooting out so bushy at the top, they are apt to smother all below. After the hedge has a second time grown large, the shoots that spring from the tops of the old stems are, however, again subjected to the axe, a few being left merely for the purpose

of nicking or laying down even with the top of the hedge. Such a fence as this never looks well; nor is it sufficient, without dead wood being put in the bottom, to prevent sheep from running through it, by which all the young shoots are either broken down or killed.

Another method which is practised by some farmers, and which is undoubtedly better than that we have just described, is that of *laying* or *plashing* the hedges. This is, however, a mode chiefly employed when they are not very old, but thin and full of gaps or spaces, where there are no plants; it is done by cutting off the stems of the quicks close to the ground, leaving only one in the space of about every foot, which is trimmed nearly to the top, nicked, or then laid down and interwoven in a horizontal position, either with such living stakes as may have been left, or dead ones set into the ground at about the distance of a foot and a half from each other. The top of the edge is afterwards bound with straight branches of hazel, or other small wood, twisted together in such a way as to inclose each stake, by which means they are supported, and the layers kept in their proper situation. From the tops of the stems which have been thus cut, and those which are nicked, in a couple of years an abundance of young shoots arise, by which an excellent thick hedge is formed. In performing this business the operator should, however, be careful to fill up the places very well where the hollows or void spaces formerly were, by laying them more closely down, and putting in proper stakes. In making this sort of hedges the persons employed begin at one end, and proceed regularly forward till the whole is laid down to the proper height, which, by a good workman, is very readily accomplished. The mode of plashing hedges practised in Hertfordshire is fully explained by plates in the Agricultural Survey of that district. In suitable situations, stakes of willow or alder may be employed with advantage, as they frequently take root and grow well. This is an extremely good method of renewing an old hedge under such circumstances. The principal objection to the above plan is, that in the course of a few years the layers, especially if they be thick or strong ones, die, and the young wood underneath is much checked and injured in its growth by the droppings from them and the decayed bindings.

But the best, and probably the most advantageous method of renewing an old hedge for the farmer, particularly where it can be protected from cattle, is that of heading the whole down to within a few inches of the ground or bank. By this means in a couple of years an astonishing quantity of young wood is produced, so as to form a hedge that can scarcely be seen through. Where there are ditches, the scourings may be thrown up to the roots, which serve as a sort of earthing up to the plants, and make them grow with greater vigour and strength. By this method, however, if the hedge be old, many of the larger thorns will frequently die. In laying the earth up to the roots great care should be taken, as injury is often done by overloading them, whole fences being sometimes destroyed in that way. Where, however, the plants are cut close down, and suitable earth applied over them, a great number of vigorous shoots

are not only sent out from each stem, but, from their being in the ground, frequently take root, and become independent plants, by which the bottom parts of the hedges become extremely thick and close. A slight stake and edder fence must be made in order to preserve the shoots from being cropped and destroyed. Part of the wood which has been cut off the hedge serves for this purpose; the remainder being either employed in making other fences, or made into bavins for the use of bakers *, &c. by which a considerable profit is immediately produced. By this method, too, where there are ditches, the sides of the banks are much preserved from being destroyed by cattle, as the plants shoot out both on the sides and the tops of them.

This seems, therefore, to be a much better practice than that of making a solid face to the bank, by means of either sods or stones, as the young wood is not prevented from growing on the sides of the banks, or the banks so liable to be thrown down by animals. Besides there is considerably more produce of wood from the hedges, which in many situations is an object of great importance.

There is a mode of fencing, which is sometimes adopted in exposed situations, where the soil is sufficiently good, which is that of planting full grown sloe, or black-thorn, pretty thick, and mixing with them hazel, withey, the large briar, &c. cutting off their tops to the height of about three feet, on a bank raised from two to three feet, with ditches sufficiently deep. This is not, however, a method to be recommended, except in such kinds of bleak situations as have been just noticed. The black-thorn abounds in most places, and may therefore be easily procured. The loppings of the plants may be stuck along the side of the bank, being well secured by suitable stakes, so as to guard the stocks from being injured by cattle or sheep. This sort of fence is made at an extremely cheap rate, from the low price of the plants; and from their throwing out shoots very extensively, with the assistance of the briar, in such situations, sometimes soon form a close and impervious hedge.

In this way this sort of thorn does not, indeed, grow to any great height, but sufficient with the bank for the purposes of confining and sheltering animals. If the fields be in a state of arable cultivation, the ditches, when made of a good depth, will prevent the running of the roots from obstructing the plough.

Where land is much exposed to the sea air, it is found extremely difficult to raise quick fences upon it; as this air, probably from the superabundant quantity of muriatic acid which it conveys, and which is readily separated from it on account of its loose state of combination, is highly destructive to the white-thorn and several other plants employed in the making of hedges. The best mode in such situations is probably that of planting beech, as it seems, in a great measure, proof against the injurious operation of this kind of air. The bank on which it is to be planted should be six or seven feet high, and four or five in width at the top; on which the young beech plants are to be put in, in two or three rows, at about the distance of

* In London these bavins generally sell at about a guinea a hundred, delivered.

a foot from each other, and sufficiently thick on the rows. In most cases no ditch is made; but in some instances the banks, or mounds, are prevented from crumbling down, either by a low-stone wall or some other suitable means. The growth of these plants is rapid; they therefore soon form not merely an excellent and beautiful fence, but one that is highly advantageous both in respect to the shelter which it affords, from the leaves being retained to a late period, and the annual profit that may be derived from it; as when at maturity one of the rows may be alternately cut and converted to various uses, and the other plashed or trimmed so as to yield much wood for fuel or other purposes. This sort of hedge has, however, one great disadvantage, which is that of requiring so large a quantity of earth for the making of the bank.

In situations such as the above, furze may often be made use of for a fence, as the young furze grows quickly, and without much difficulty, if they be raised by sowing the seeds thickly upon pretty high and broad banks, with ditches on the sides. As the old parts of furze soon die away, it will always be necessary to guard against the thinness produced in this way; which may probably be best done by cutting the plants close down first on one side and then on the other, every two or three years, to admit of which is the principal design of such a broad bank; and thus have a fence on one side or the other constantly in perfection. The cuttings obtained in this manner may in situations where fodder is scarce be made use of, when bruised, as an article of food for animals. This mode of training furze fences is, however, objectionable, not only as wasting a great deal of ground, but as being liable, from the seeds being scattered over the inclosures by the wind, to fill them full of this almost ineradicable plant.

In planting hedges of willow and other aquatic plants, the ground should always be made as mellow and friable as possible, and the shoots to be employed of two or three years' growth, and fresh cut off at the time of using them. They are then to be put into a narrow ridge of ground, prepared for them, at the distance of eight or ten inches from each other, the tops being bent different ways, and plaited firmly together, so as to make a fence. The gray willow is probably the best kind for this purpose. In some instances the sweetbriar may probably be mixt with the willow to advantage.

Whatever sort of fence is made in such situations, it is perhaps a good practice to raise a pretty high bank with a ditch on each side, and in some cases to plant hedges in each face of the bank, so that it may afford shelter to them while they get up, and that afterwards one may protect the other, and render their growth more rapid.

Several fences of these different sorts are exhibited in plate LXVI. in which, fig. 1. is a hedge in the middle of the wall; and fig. 2. a view of a hedge and ditch with a row of trees on the top.

Fig. 3. shows a furze or whin hedge on the bank faced with stones. Fig. 4. a furze hedge placed merely at the top of the bank. Fig. 5. shows an old edge cut over, and the young growth of the first year upon it. Fig. 6. is an old hedge cut over, some of the old stems left uncut and warped in, to fill up the vacancies. Fig. 7. represents the common quick-hedge, with the stems nicked and bent down a

PL. LXVI. 8°.

HEDGE FENCES.

Fig. 1.

Fig. 2.

Fig. 3.

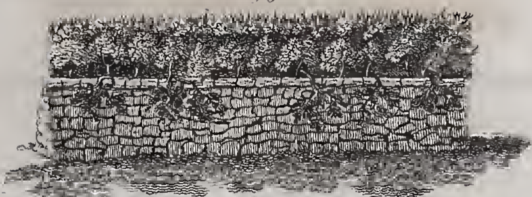


Fig. 4.

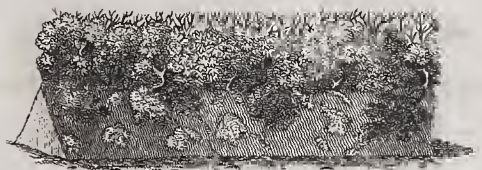


Fig. 5.

Fig. 6.

Fig. 7.

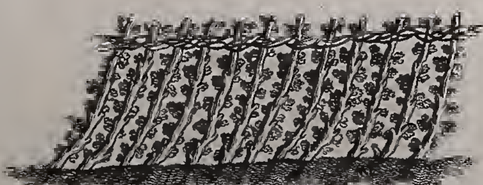


Fig. 8.

HEDGE FENCES.

Fig. 1.

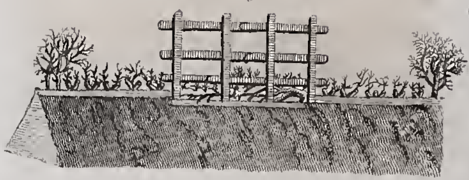


Fig. 2.

Fig. 3.

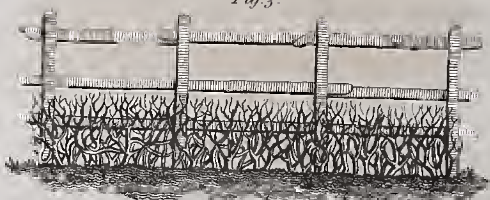


Fig. 4.

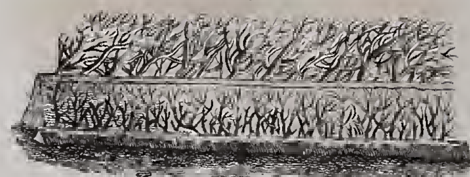


Fig. 5

Fig. 6.

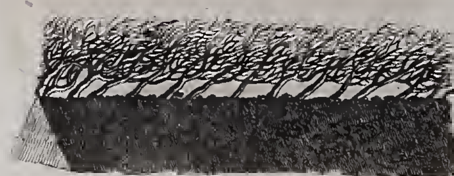


Fig. 7.

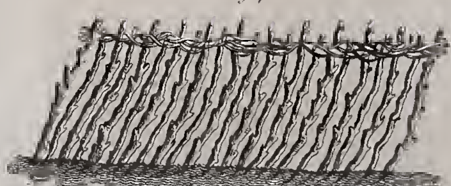
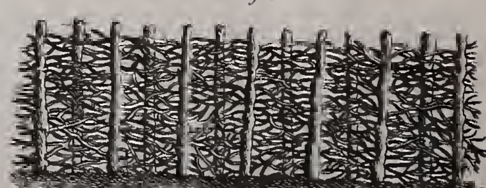


Fig. 8.



little, being then bound at top with willows or hazels. And fig. 8. exhibits the method of mending a gap, where the old hedge is cut down, by laying one of the old stems, and confining it by hooks, then covering it with earth, so as that it may send up numerous shoots to fill up the vacancy.

And at fig. 1. in plate LXVII. is represented a hedge repaired in the manner as at fig. 8. in the preceding plate, and protected by a strong paling in the opening. Fig. 2. exhibits an old thorn-hedge cut down, and an opening repaired by planting young beech-trees, protecting them as in fig. 6. Fig. 3. is a hedge and paling. Fig. 4. is a hedge with a dead hedge on the top of the bank for protecting the young plants. Fig. 5. shows a hedge with ditch, having a coarse wall on the bank to protect the plants. And fig. 6. represents a common dead-hedge. Fig. 7. shows a dead-hedge bound together at the top by edders. And fig. 8. represents the form of dead-hedge usually termed *stake* and *band*, and sometimes *stake* and *rise*. In it the dead materials are wattled in between strong stakes.

The filling up the deficiency of hedges, of whatever kind they may be, with dead materials, though a very common practice, should be had recourse to as seldom as possible; as the hedges are by this means not only prevented from throwing out young shoots to fill themselves up, but the dead materials when they begin to decay leave larger openings than existed before they were introduced. Where hedges are disposed to become mossy, the mixing of lime, ashes, or such-like substances with the mould of the banks, may frequently be of considerable utility in removing it.

In some situations, hedges made solely of dead materials are had recourse to as a means of dividing inclosures. This is, however, a practice, which, from the great expense of forming them, their constant tendency to decay, and the necessity they have for annual repairs *, should never be adopted when there is a possibility of raising living fences, except indeed when they are merely used, as has been already noticed, by way of a protection to young quick hedges. For the former purpose, the longest part of the cuttings from living fences, or other places, are wattled by means of stakes driven into the ground at sixteen or eighteen inches distance from each other, and bound on the top by means of ash, hazel, or willow bindings. This is termed a *stake* and *band* hedge. With the latter intention, the shorter and more bushy sort of cuttings are generally employed, and either stuck into the ground on the surface, the side, or top of the bank in a slanting direction lengthways of the fence, and inclining a little towards the inclosure, or made into a low stake and band hedge, in the way described above. In making this sort of fence, great care should be taken not to place the dead materials too near the living plants, as by such inattention they are frequently much injured and retarded in their growth, from the falling down of the rotten and decayed parts of the wood.

Ditches.—These are constructed with different intentions; being

* These, in some instances, amount to from a sixth to an eighth or tenth part of the rent.

sometimes formed only as a part of a fence, or as a drain, while at others they serve equally the purposes of drainage and inclosure. But for whatever purposes they are designed, they should always be formed with sloping sides, as when they are cut perpendicularly down, the surface of the land, or the sides, is liable to give way and fill them up. In forming ditches, regard is likewise necessary to the peculiarity of the soils, and the nature of their drainage, in order that they may be dug in a suitable manner in respect to depth, and the direction most convenient for conveying away the water: much mischief being frequently occasioned by its remaining in a stagnant state in them, from these circumstances not being properly attended to.

When ditches are made for the purpose of fences, they should be sufficiently wide to prevent animals from getting over them, and be more than usual sloped in the banks, that cattle may not so readily poach them in. In general, from seven or eight to ten feet in width, and from three to five in depth, constitute a pretty secure fence. Ditches of this sort ought also to be more frequently cleaned out, and have their sides well pared down, than is the general custom among farmers; as by these means the grounds on each side, and in the neighbourhood of them, are more effectually drained, and the water rendered much less stagnant and pernicious to the health of plants and the inhabitants of the districts in which water-ditches abound. The earthy materials obtained by this means may often be converted to a very useful compost manure for various kinds of grass-lands, by being well mixed with a suitable portion of rotten dung.

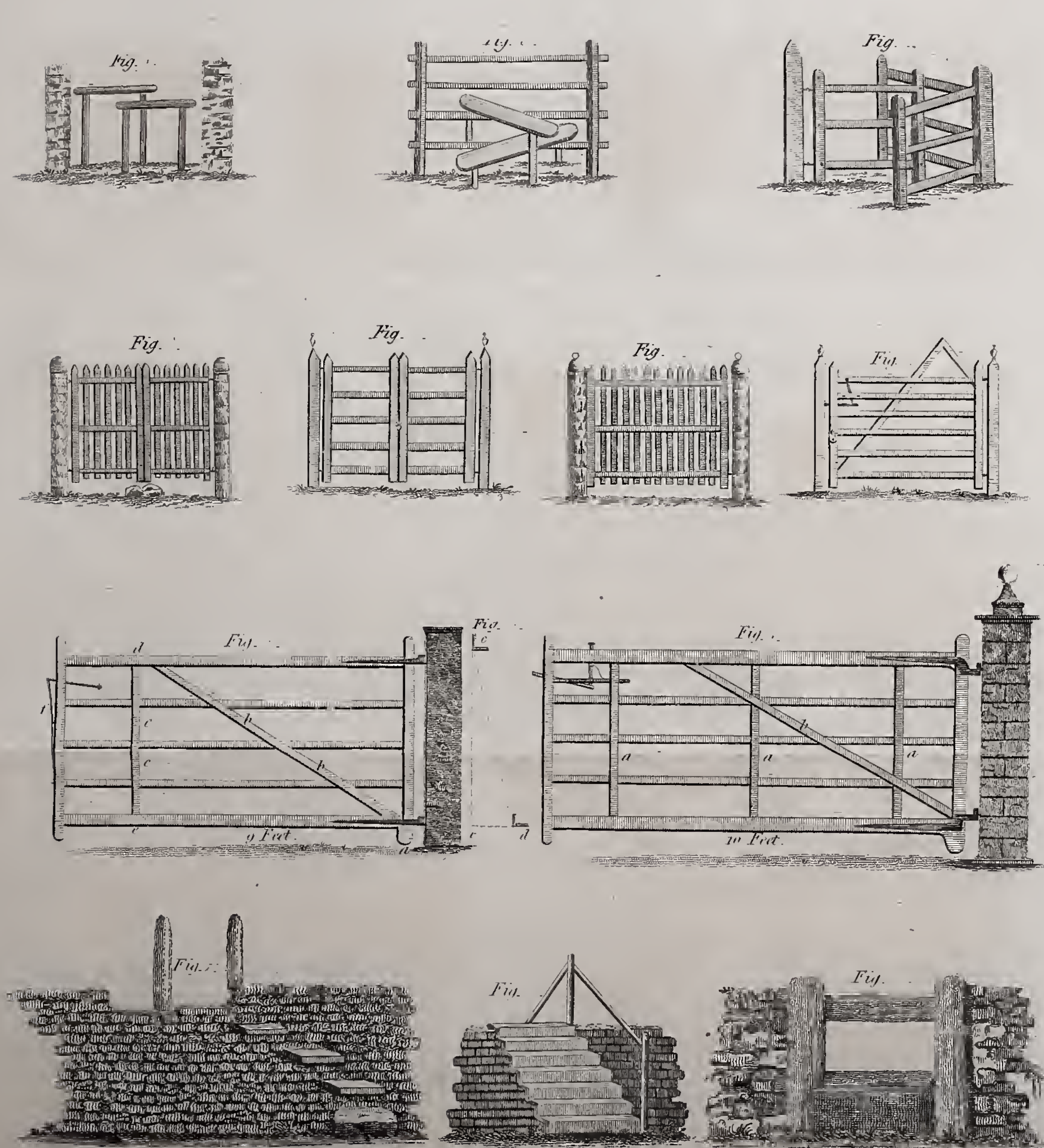
Care should likewise be taken that they have proper communications with suitable outlets, as the brooks or rivers in the vicinity of them, as by a neglect of this much mischief is frequently produced.

In wet marshy situations, large spaces of ground are frequently left between ditches which act as drains. Under these circumstances, perhaps the best and most profitable method that can be adopted, is that of planting them with osiers and the bitter willow, as by such a plan the farmer reaps advantages in other ways, as well as that of a fence.

Where hedges are made, the ditches, as has been shown, are either single or double; the latter is more suitable where much water is to be taken off from the adjoining land; and, in cases where the earth is well thrown up in the middle, a tolerable temporary fence may be formed.

Gates.—There is much variety in regard to the materials and the manner in which gates are constructed, as well as the way in which they are hung; some consisting of two leaves, others of only one; some moving on the centre, and appearing like two gates; others turning on one end; some opening to one side only, others swinging both ways by suitable crooks and eyes. Where oak, ash, or other heavy kinds of wood are employed for these purposes, the hanging-posts ought to be placed deeper and more firmly into the ground; as the gates made of these woods are extremely heavy, and consequently liable to drag the hanging-posts forwards: but they are

GATES & STILES.



probably more durable than those made of the lighter sorts of wood.

The Dutch willow and several other of the lighter kinds of wood may, however, be converted to the purpose of making gates with very great advantage to the farmer, as they may often be cultivated on waste spots of the wetter sort of ground, and grow so rapidly as to be fit for use in the course of six or seven years. Gates made from materials of this nature are also, on account of their lightness, much more durable than is generally supposed. But whatever sort of wood is made use of in the constructing of gates, it should always be perfectly dry and well seasoned; for, if that be not sufficiently attended to, they soon begin to crack and give way when exposed to the weather, especially in the summer season.

In the construction of the *swing-gate*, the bars are so long that too much weight is often thrown upon the hinges, by which they are frequently liable to be strained or broken; and, unless the joints be put together with great correctness of workmanship, they soon give way.

This therefore, though an expensive, is by no means a good form of gate. The *double* or *folding-gate*, from the bars being only made about half the length, is found to be more lasting, and not liable to the inconveniences of the above. It, however, requires an additional pair of hinges. The *slip-bar-gate* is a form of gate often used, and which, from its cheapness and simplicity, may be very proper and lasting. It merely consists in having posts fixed up, with mortises cut in them for the bars to be slipt into. However, from its being tedious in being opened, and not being capable of being locked or well secured, it is probably the most suited to the inner inclosures of the farm. The *turn-about* or *wirlout-gate* is only necessary where a frequency of passage is required.

A very useful form of gate is described by Mr. Robertson, in his Survey of the County of Perth. "The back of the gate itself," says he, "(independent of the post on which it hangs) has a projection of three inches in the timber on the fore side, rising nine inches from the foot of the moveable part. On this projection rests the back end of the diagonal bar, which points upwards to the fore part of the gate, and reaches about four feet and a half in that direction. This diagonal bar is of such a thickness, that every one of the horizontal bars pass through it, nicely mortised, except the lowest and the highest. About six or ten inches from the termination of the diagonal bar above, there is a perpendicular one fixed in the two outside ones above and below, and of such a thickness as to admit all the rest to pass through it, mortised as they are in the diagonal bar. The rest of the gate is made in the ordinary way, and may be of any length. Some of them are," he says, "made double, having more than one perpendicular bar; but these appear to be too complex, and to have too many joints. The excellence of this gate is, that all the horizontal bars, except the highest and lowest, rest, not on the posts only, but likewise on the diagonal and perpendicular bars; and that the diagonal bar itself rests on the projection of solid wood at the foot of the back post; so that it is impossible the joints can start or the

gate come asunder, until the timber rot; or that the gate itself can fall forward, unless the pivot on which it moves, or the pillar on which it hangs, be faulty. It is far superior to any gate whose diagonal bar is fixed only by nails to the horizontal ones."

For the uses of the farmer, those with five bars, properly braced, are probably the best. They should be about eight feet and a half or nine feet in width, and from four and a half to five feet in height. The bars ought to be made strong, having the depth of three inches and a half.

Different gates of these kinds are represented in plate LXVIII. in which fig. 1. is a common *swing-gate* with simple cross-bar or brace: and

Fig. 2. is the common upright *swing-gate,* which is more close than the former.

Fig. 3. is a *swing-gate* on an improved principle: *a* the projection on the fore part of the *bar-tree,* rising nine inches, on which the lower end of the diagonal bar, passing upwards, rests; *b b* the diagonal bar, through which the three middle horizontal bars pass; *c c* a perpendicular bar fixed into the uppermost bar six inches from the insertion of the diagonal one at *d*, and into the lowermost at *e*; *f* the spring on the fore-tree by which it fastens. This is a strong, useful gate for common purposes.

Fig. 4. is a *double-gate* of the same sort; *a a a* three cross-bars; *b* the diagonal bar, as in the former. The great objection to this form of construction is the great number of joints. Fig. 5. is a *common folding-gate,* which is very useful in many cases. And fig 6. is a *close folding-gate.*

The hanging of gates is likewise a point that ought to be attended to, as they are soon destroyed when they are fixed in such a manner as either to drag upon the ground, or go with too much velocity in shutting. The proper inclination or tendency to shut of themselves may be easily given them by a regard to the following circumstances:—The hanging-post being set perpendicularly in the ground, a plumb-line must be drawn upon it, on which, at a proper distance from the top, put a hook so that it may project three inches and a half from the face of the post; and at a suitable distance below this, the lower hook must be inserted an inch and a half to one side of the perpendicular line, having a projection of two inches from the face of the post; the top loop is then to be put two inches from the face of the haw-tree, and the bottom loop three inches and a half from it. Gates when thus hung will be found to have sufficient fall, in every position, to shut without any trouble or inconvenience. It is represented at fig. 15. in the same plate in which *a b* is the plumb-line drawn on the post; *c* hook projecting three inches and a half; *d* lower hook placed an inch and a half on one side the line, projecting two inches. Thus if the loops be put in as above, and the weight of the gate be represented by the line *a b*, by the resolution of forces it is resolvable into other two, *c c* and *d e*, the former representing that part of the weight which presses in a perpendicular position, and the latter that which presses in a horizontal direction and gives the gate a tendency to shut.

The true principles on which this depends have, however, been lately more fully investigated and explained in an able Essay on the Construction, Hanging, and Fastening of Gates, by Mr. Parker; in which it is stated, that, when suspended by hinges, a gate is a lever of the second kind, in which the weight is placed between the power and the fulcrum; as it is evident that the hand applied to the head of the gate is the *acting power*; the gate itself, the weight to be raised or moved, and the hinges, the fulcrum or centre of motion. "When the hooks or pivots upon which a gate is hung are precisely perpendicular to each other, the gate will be at rest wherever it may be placed, and the same power which is required to move a gate thus suspended through any given arc of the circle, will be exactly sufficient to bring it back to its former position;" a proof of which is seen in a common door to a room with plain hinges. "But the smallest variation of the hooks from their perpendicular line will attach to a gate so suspended one determinate line of rest; and from any part of the circle which the gate may be made to describe, it must have a constant tendency to fall to that line of rest. The line of rest for a gate will always be where it approaches nearest to the ground; and from thence being moved half a circle to the right or left, it will there attain its greatest elevation, and support itself, or, with a very slight assistance, may be supported in equilibrio. When a gate is in its line of rest, or in its opposite line of equilibrium, the two hooks by which it is suspended, and the centre of the gate's gravitation, will be in the same vertical plane with each other; which may be easily understood by observing a common gate, whose hinges are put on in any manner, however awkward or perverse. And when the hooks are in one perpendicular line, it can admit no doubt but that they must always be in the same vertical plane with the centre of the gate's gravitation, because they will be so with any third given point whatsoever. These principles are also applicable to a common swing-gate, which has two or more pivots or hooks at the lower hinge, when the position of either one of the lower pivots is considered with respect to the upper hook." In explanation of these principles, a figure is given which is supposed "the outline of a gate nine feet two inches long, from the fore part of its head to its upper point of suspension, represented in the line of rest, as well as in the opposite line of equilibrium, showing the velocity with which the gate is made to fall from an elevation of six inches gained at the head in attaining its line of equilibrium, estimated from the line of rest by means of the position of the two hooks, and the proportionate extra length of the lower thimble." And it is contended that "the line of fastening should be 22° 30′, or 1-sixteenth part of a circle, short of or within the line of rest; and consequently the corresponding line of equilibrium will also be 22° 30′ short of the greatest extent of the gate's opening." But in order "to prevent the gate being left unshut, it is advised that a short post should be placed at about half the distance between the road to be passed and the fence adjoining the hanging-post, that is 22° 30′ within the line of equilibrium; so that the gate should not open from its line of fastening more than about 135°, which will

answer every purpose; and the hinges must be so adjusted that the gate shall be perfectly upright at its line of fastening." It is stated that a gate suspended in this manner cannot be left open, (excepting in high winds) but will shut of itself, though not with an uniformly accelerated motion, as might be supposed; its velocity being rather increased as it passes the middle part of its semi-circular course, and retarded again as it approaches its line of rest coinciding with the proportionate rise of the head, allowing only for such acceleration as must be acquired while the gate, in falling with a continued motion, recedes more and more from the line of equilibrium. As the *versed sine* of the angle formed by the gate with its line of rest is to the length of the gate 110 inches, which is the made radius, so will be the corresponding rise of the head of the gate to $3\frac{7}{16}$th inches, or half the whole rise of the gate's head, at any given angle within the quadrant: and the rise in the head afterwards will be, as the *co-sine* of any given angle formed by the gate with its line of equilibrium in describing the complement of that angle is to the length of the gate, or radius, so will be the corresponding rise of the head of the gate to the remaining $3\frac{7}{16}$ inches, which *co-sine* of the angle formed by the gate, with the line of equilibrium, is equal to the sine of the complementary angle, or angle of the gate's progress, from a radius at right angles to, or equi-distant from, the lines of rest and equilibrium, in performing its supplementary course. Thus it appears, that though the rise of the gate at the head in the first 90°, or half of its semicircular course, be $3\frac{7}{16}$ inches, yet in the first and last 22° 30′ of its course, it will rise only 1-fourth of an inch, or exactly $\frac{6}{\cdot}$ ths and $\frac{69}{116}$ths of a 24th in each respectively; and rejecting the greater fractions, the rise of the gate's head, and corresponding velocity of the gate's fall, in equal eighth parts of its semicircular course, is nearly in proportion to the numbers, 6, 16, 26, 32, and then inversely 32, 26, 16, and 6.

And in further illustration of the above principles, a "representation is given of the horizontal section of two hooks for a right-handed gate, opening one way, brought into one plane of observation; the upper hook, the lower hook, the line of fastening, the line of rest, and the line of equilibrium. The diameter of the hooks $\frac{1}{4}$ths of an inch, which is the proper size for a common gate. The horizontal distance of the lines falling from the two hooks being $\frac{2}{4}$ or $\frac{2}{2}\frac{1}{1}$ inch, is the measure adapted to hinges which are forty inches asunder. In adjusting the hinges, it is necessary that the upper thimble should incline $\frac{1}{4}$ inch from its centre towards the hanging post, and that the lower thimble should be screwed into the heel of the gate $\frac{1}{4}$ inch out of the straight line, inclining in the opposite direction; that is, from instead of towards the hanging-post, both thimbles together making a variation of the $\frac{6}{1}$ inch; and to correspond with this variation, the upper hook should measure, from the centre of the pin to the shouldering, about half the thickness of the heel of the gate, as the $\frac{1}{6}$ inch inclination of the upper thimble will allow sufficiently for the gate hanging clear of the post. The lower hook must be $\frac{6}{12}$ inch longer than the upper hook, and must be driven into the gate-post $1\frac{1}{6}$ inch out

of the perpendicular line of the perforated parts of the gate-post, in which the hooks are to be received, as the lower thimble must also exceed the upper thimble in length $1\frac{2}{4}$ inch, supposing the gate to be a right-angled parallelogram, or at least the rail and heel to be at right angles with each other; else the lower thimbles must be extended by a washer to make up the deficiency, which, however, will not at all interfere with the velocity of the gate's fall, because the hooks are the centre of motion upon which all adjustment, as to the gate's fall, depends, the places of the thimbles influencing only the upright position of the gate when fastened. The numbers of $\frac{6}{12}$ rather surpass the precise measure of their respective sides of the triangle, but are nearer to the truth in calculation than any workman could attain in applying these directions; for in neither case do they exceed their true measure so much as $\frac{1}{24}$ of an inch, and therefore in the one the clear sum of $\frac{1}{2}$ inch is assumed for general purposes; and should the hinges be less than 40 inches asunder, $\frac{1}{2}$ inch will be rather too much; or were they to be more than 40 inches distant from each other, $\frac{1}{2}$ inch, on the contrary, would be rather too little for the just proportion. It is certain that a small space must be lost in hanging a gate, though the hooks and thimbles be made with great exactness; for the weight of the gate will draw the upper thimble to bear upon the hind part of the upper hook, and will press the lower thimble against the fore part of the lower hook: this must be trifling when the hinges are well fitted, and no allowance is made for it; because the lower thimble gains as much upon the upper one by their being placed $\frac{1}{2}$ inch, that is $\frac{1}{4}$ inch each, out of the plane of the gate's extension, as appears by the difference of the sides of the triangle, numbered $\frac{14}{12}$ and $\frac{15}{12}$ equal $\frac{1}{11}$ inch by the measure $\frac{15}{12}$, which is assumed, but really about $\frac{1}{14}$ inch more as stated above, or on the whole equal to $\frac{1}{8}$ inch, which is a good general equivalent for the loss in hanging a gate, and will usually, be sufficient to preserve the upright position of the gate when fastened, without having recourse to a washer at the lower thimble." It is remarked that the "velocity as above given to the gate's fall will be amply sufficient without any care of oiling the hinges; but the effect of wind cannot be counteracted in gates by any good construction of the hinges; for, were a velocity given to a gate's fall equal to the resistance of so powerful an agent, the gate would soon want repair, from the constant violence of its shutting, and be so much the heavier in the hands of a horseman: besides, when a strong wind blew in the same direction as that of the gate's fall, no man on horseback would be able to withstand its force; and well-constructed gates are most liable to be acted upon by wind, from their wide extent of surface. But if passengers are so careless as to leave gates open under such circumstances, there will be one satisfaction remaining; that is, as soon as the wind ceases, the hinges must resume their property, and the gates fasten of themselves."

Various directions are given, by which the new position of the hooks may be found when the hinges of gates are more or less than forty inches asunder. In proof of the accuracy of which, "suppose a gate to be 110 inches long, and that it is intended to rise at

the head $6\frac{7}{8}$ inches in its semicircular course, from the line of rest to the line of equilibrium: then, as the length of the gate is to the distance between the two hinges, so will be $6\frac{7}{8}$ inches to double the horizontal distance of two perpendicular lines, one falling from each of the hooks." Or "take any other distance of the hinges from each other, and the required extra length of the lower thimble may be found by placing the numbers 110 and $6\frac{7}{8}$ as the first and second terms of a rule-of-three proportion, and the new distance of the hinges must be the third term; the answer, divided by two, will be the sought-for horizontal distance of the two perpendicular lines falling from the hooks (adding the loss in hanging the gate); the answer for the one is the measure for the other." It is supposed that "these general rules will find a tolerably accurate measure in all cases; for, where a gate or wicket is short and light, the friction of the hinges will be less in two respects, both by the diminished pressure on the hooks from the gate's lightness and the reduced diameter of the pivots, which will supply what is wanting in the weight or momentum of the gate. On the other hand, when the gate is long and heavy, its increased weight or momentum, and its length as a lever, will be opposed to the additional friction of the hinges." And "in cases where old hinges are badly made, with large hooks or deep thimbles, that difficulty is to be met by taking the proportion for the distance of the two hinges from each other at five or ten inches more than it really may be, with reference to the given table, or by adding something to the usual horizontal distance of the lines falling from the hooks. But when the thimbles are of a long cylindrical form they are extremely apt to bind upon the hooks, and will sometimes put a dead stop to the gate's motion. With such thimbles, the attempt of adding to the velocity of a gate's fall may only increase the binding or friction; and the remedy for this defect, therefore, is to make the hooks much smaller than the thimbles: in new thimbles, no form but that of annular, or ring-like, should be admitted." By "the lower thimble being furnished with a screw of equal diameter throughout its length, its extra length may be regulated to so great a nicety as half a turn of the screw, and may either be let into the heel beyond the shouldering, or lengthened out by a washer, as circumstances require, in adapting it either for hinges, which are less than forty inches asunder, or the contrary, without the help of a blacksmith or any fresh forging, which is always troublesome and expensive. And if a gate sinks at the head, without any fault in the hanging-post or hooks, the lower thimble may be lengthened out to bring the gate upright, and the hooks remain unaltered."

Gate-posts, where they can be had, are best of stone; but where wood is employed for the purpose, it should be sufficiently strong, and set a great depth into the ground, being previously prepared by tar or oil-plant in that part. And it is further observed by the same writer, that "when gate-posts are fixed about eight feet nine inches asunder, they will be adapted for a gate nine feet long, or nine feet two inches including the thimbles. The thimbles being attached to the gate in the manner above directed; let the gate be supported

where it is to hang and fasten, and then drive in the upper hook at a convenient distance from the edge of the hanging-post, so that the upper hinge shall not be in the way of any carriage passing the road, but at the same time so near to the edge of the post as to lose no more room for the road than is unavoidable, by the head and heel of the gate extending a little upon the two posts. It is not necessary to the gate that it should lap against the hanging-post at all; but since the head ought to meet the falling-post, at least with half its own substance, or from that to two inches, the hanging post should be nearly as much covered by the heel for the sake of uniformity. When the upper hinge is fitted, the gate ought to be supported upright, for ascertaining the place of the lower hook; and if the thimbles are properly put on, the position of the lower hook cannot be mistaken. Both hinges being fitted, it remains to be found whether the hooks are in their exact places: for this purpose take two plumbed lines with fine threads and heavy even sided plumbs; if the hooks are well finished, the observation respecting their centres may be taken by fastening the plumbed lines round the hooks, and letting them fall from the outsides of similar parts of the hooks:—forty inches being the given distance of the hinges, the horizontal distance of the two lines falling from the hooks should be $1\frac{1}{4}$ inch, and in a line which forms an angle of 22° 30′ with the gate's line of fastening; take, therefore, a common two-feet rule, and, having opened the legs to the angle of 22° 30′, place one side of it against the plumbed lines, which ought to answer to the measure of 1^1 inch, while the other leg of the rule should be parallel to the gate's line of fastening: a slight blow or two with a hammer on one or both of the hooks, in the direction necessary, will complete the adjustment; and the gate will be found to shut of itself from any line within 135° from its fastening, and without violence, whether opened to the smallest, the greatest, or any intermediate angle prescribed by the short post, which should be placed to meet the middle part of the gate at the angle of about 135° from the line of fastening." And "it might be prudent, before the short post were put down, to ascertain at what line the gate will stand open, or be poised by the friction of its hinges towards the line of equilibrium, which will discover how near the workmen may have adjusted the line of fastening to 22° 30′ short of the natural line of rest; and if the gate is found to fall properly, the short post may be put up accordingly, though the method described may not have been minutely pursued, taking care that the short post be sufficiently within the line of equilibrium, and that the gate set off from the short post with a velocity equal to overcome any increased friction by rust on the hinges; for oil should not be used at all, as its occasional aid is not to be depended on."

It is observed that "indifferent gate-posts are liable to get out of their upright position; the constant weight of the gate must have a tendency to pull the hanging-post inwards; the fall of the gate may make the falling-post recede from the direction of the frequent blows it receives, and heavy carriage-wheels passing near the posts

will occasion them to open outwards; and the natural or artificial slopes of the ground adjoining gate-posts often affect their upright position, and decline them from the higher ground," and many other causes produce similar effects, to obviate which many contrivances have been recommended; such as "mortising the pair of gate-posts together by cross pieces of timber under the road: but the most effectual preventive of the evil appears to be that of letting down the posts very deep into the ground, which will supersede the expense of cross timbers; and in gaining a firm hold at their bases, they will be the better secured both from natural and accidental displacement." Gate-posts for common gates should be from eight to eight feet and a half in length.

Care is also "to be taken, in hanging a gate, to choose the best side for it to open; in doing which there are two circumstances to be considered: the principal one is, that there may be plenty of room for a servant on horseback to hold the gate while a carriage passes; and the other is, to avoid its opening against any cross road or path: add to which, some attention is due to the trespass of cattle from a common road, or otherwise; and it is thought more secure for a gate to open against that side from which the trespass may be most apprehended. In some cases it is advisable to furnish a hanging-post with a pair of hooks on both sides of it, so that the gate can be shifted as occasion may make it convenient."

A key-hole and cotter may be put in the lower hook "to secure the gate from being taken off the hinges for idle purposes; or a stud rivetted to one side of either of the hooks, with a little notch cut in the strongest part of the adjoining thimble, is a simple and good contrivance, whereby a gate is prevented from being taken off the hinges when shut, but is easily taken off at some one part of its course when required, where the stud comes opposite to the notch, and admits the thimble to pass over the studded hook." And it is not uncommon to see one hook driven into the post with its point upwards in the common way, and the point of the other hook in the contrary direction; which is an effectual mode of keeping the gate on its hinges; but it has the inconvenience of not permitting the gate to be removed without drawing one of the hooks.

The same principles are applied in the hanging of gates on the contrary sides, and likewise to those of swing-gates; full explanations of which may be seen in the very useful Essay before mentioned, as well as the methods of sawing timber for gates and gate-posts.

The methods of hanging and fastening, as well as the inconveniences of swing-gates, are also explained with great ingenuity and practical accuracy; but they will be best understood by perusing the Essay, as they cannot be fully comprehended without the plates.

Mr. Parker has likewise found, that cast-iron may be applied with superior advantage to the purpose of hanging and fastening gates, the hooks being attached to the posts by means of screws, instead of being driven in as in the usual mode. By this means it

is supposed that a saving of at least fifty per cent. may be made. Complete sets of which are furnished by Messrs. Deermans, Francis, and Company, Eagle Foundry, Birmingham.

STILES.—These are constructed in very different forms, according to the nature of the materials and the situations or purposes for which they are intended. Where stones are in use, a thin flat one is sometimes set on edge at the bottom, to prevent small animals getting through, and a longish cross one placed at the top, to prevent their getting over. Where wood is employed, they may have various forms, according to the ingenuity of the workman. Different stiles are represented in plate LXVIII. in which fig. 7. is a common stile. Fig. 8. another common stile. Fig. 9. the *wicket-stile*. Fig. 10. the simple stone stile. Fig. 11. the *Cornish stile*. And fig. 12. an improved stile with rail.

It is well remarked by an intelligent writer on the subject of inclosing, that "every gentleman, whose estate is not already inclosed, will perhaps find his account in beginning with a survey and plan, distinguishing the different kinds of soil, marking the land fit for tillage, and that which is only fit for grass, and the plantations distinct from both. He will thus have the whole under his review at once, and have leisure to examine, to digest, and to amend his plan, both according to his own judgment, and to hear and weigh the remarks of the best improvers in his neighbourhood, who have distinguished themselves by their taste and their knowledge in rural affairs. This is the time to correct the general plan, rather than to undo any part after it is executed; which always implies weakness, precipitancy, and unnecessary expense. The whole will be divided with propriety and precision, so as to render it most beautiful and most convenient; and every part will be destined to its proper use."

It is also observed in the same work, that "various methods have been adopted in defraying the expense of erecting inclosures in the first instance, and of preserving them in proper repair. In place of giving any detail of these, let it," says the writer, "suffice to mention what appears to be the most equitable and effectual. If a farm is to be inclosed and subdivided at the commencement of a lease, the whole expense of making the fences ought to be laid out by the landlord, who has a permanent interest in the ground; and in the gross sum of the rent, an equivalent may be charged for the interest of the money expended in inclosing. If, on the other hand, a farm is to be inclosed during the currency of a lease, the proprietor ought," he thinks, "still to lay out the money, and a contract be made with the tenant to pay such an additional rent, in name of interest, as may be agreed upon betwixt both parties. In the provision made for maintaining the fences in proper repair, the expense ought always to be mutual and equal on both sides, for very evident reasons, and these repairs executed by skilful labourers, when required by either party, and completed to the satisfaction of the landlord. Few disputes," he says, "take place about fences, unless the agreement be very bungling; the great bone of contention is, the keeping the fences in order; and it is presumed that, by the

provisions pointed out, much contention and many expensive law-suits at the end of leases may be avoided."

There can be little doubt but that by attending to such circumstances the proprietors of land may frequently avoid improper modes of managing the inclosures of their estates, as well as prevent the fences, when once formed, from falling into that state of ruin and decay which is too often the case where no suitable regulations in these respects exist between landlords and tenants. The general business of inclosing may likewise be rendered more easy and convenient, and thus afford encouragement to the best, and probably the only means of introducing the most improved and advantageous methods of cultivation, and the reception of the greatest possible produce from the land.

SECTION V.

Construction of Roads and Embankments.

IT cannot be doubted but that good and convenient roads are of great use and advantage, whether considered in an agricultural or commercial point of view; yet the best means of forming and preserving them seem, till lately, to have been but very little examined or attended to. This will be obvious to every one who inquires into the subject, as he may frequently find them laid out in the most inconvenient and injudicious lines of direction, and constructed with considerable disadvantage in respect to materials, and the manner of their application. The division of roads into public and private, carriage and horse tracks, may be sufficient for the present purpose. In marking out and directing new lines of roads, the surveyor, or the person who has the management, should constantly keep in his mind a few leading principles, by which the business ought always, as much as possible, to be regulated; such as those of fixing on the most level, the shortest, and the cheapest lines: for though they can, perhaps, be but seldom entirely followed, they should be regarded, in every instance, as much as is in the power of the person who marks them out. Where, however, these different advantages can all, or several of them, be united in the formation of a new road, it will certainly be advisable to proceed, without hesitation, in such a line: but where that is impossible, which, as we have just observed, must frequently be the case, that line or direction should be adopted which is the most level; for it is obviously better to go some way about in order to procure a level road, than to go in a straight direction, and have a hilly, uneven one. Small elevations, or ascents, should not, however, be much regarded, as they may often supply materials for the lower hollow parts, by which means the road is not only more conveniently made, but rendered nearly level. It may also be sometimes necessary to pass in the

direction of slight hills, with the idea of having a sound, firm bottom, and a road easily made; or to avoid swamps, morasses, and sheets of stagnant water, through which roads are made with great difficulty and much expense. Besides there are often other advantages in taking such directions: as it can scarcely have escaped observation, that such roads as are formed on a gentle declivity always wear the best, are the cleanest, and kept in repair at the least expense. In all flat countries and level situations, a slight declivity should indeed constantly be given to the roads in their first formation, which can easily be accomplished by those who understand the nature and proper construction of them.

It has been well observed by a late writer, that where the country is perfectly flat, without any obstructions, which is very seldom the case; and where the surface of the country between the points or places to be connected by roads is nearly but not quite level, from the intervention of gentle swells rising between them, the straight line may be perfect and the most eligible. But where the intervening country is much broken into hill and dale, or there is only a single ridge of hill, the straight line is seldom capable of admitting perfection. In such cases, which are almost general, the great art lies in tracing the midway between the straight and the level line. And "the line of perfection for agricultural purposes is to be calculated by the *time* and *exertion* jointly considered which are required to convey a given burthen, with a given power of draught, from station to station." But "on great public roads, where *expedition* is a principal object, time alone may be taken as a good criterion." And it is added that a regular method of finding out the true line of road between two stations, where there is a given blank, without any other obstruction than what the surface of the ground to be gotten over affords, is first "to ascertain and mark, at proper distances, the *straight line*, as being the only certain guide; for when that line is found ineligible, each mark becomes a rallying point, in searching on each side of it for a better. That where two lines of equal facility and nearly of equal distance from the straight line present themselves, the choice should be determined by correct measurements. And that where one of the two best lines which is afforded by the intervening country is found to be easier, and the other shorter, the ascent and distance are to be considered jointly; and the exertion and time required weighed with due deliberation. Beside, the *nature* of the ground, the *source* of materials, and the general comparative *expense*, of constructing the road, by two doubtful lines, together with the difference of *exposure*, are to be attentively considered.

In respect to the *ascent of hills*, whether in laying out or altering old roads, it has, he says, been injudiciously the practice to give an uniform rise from the bottom to the top of the ascent; which in a mechanical point of consideration may be proper: but where the moving power is neither purely mechanical nor sufficiently rational, but an irregular compound of both, the nature and habits of that power are to be attended to. This is supposed one of the variety of instances which "show the impropriety of applying purely mecha-

nical principals to agriculture and rural concerns; in which they are to be combined, not only with the power, but the will, of animals. No person, it is conceived, who is fully acquainted with the nature of the draught of a teem, in a hilly country, would lay out a long line of ascent, without one or more breaks or convenient resting-places, in which the draught animals may relax from their labour, and set off again in an easy manner. It may easily be theoretically supposed that the carriage may be safely stopped at any point of the ascent by the aid of the drag staff or fall, but in practice the danger of checking the efforts of beasts of draught, while struggling against the collar, is well known, as well as the different inconveniences that accompany it, in different animals. When the natural surface of the ground is well considered, there will be little difficulty in assigning proper places for rests, so as to render the road not only more easy for heavy carriages, but safer and more pleasant. Besides, they are more easily kept in repair, from these being checks to the surface water, and affording convenient places to discharge it without injuring the surfaces of the roads. Such breaks apart, the line of ascent should, however, be as nearly uniform as the nature of the circumstances will admit. In setting out roads in these cases, the levels should be taken by observation from the bottom to the top of the ascents, previously determined upon in the manner directed above; or from station to station, where clear views cannot be had between the different points, and the degrees of ascent thus ascertained marked upon the instrument; by which mark a rough line must be traced along the face of the hill, in order to decide with proper correctness in respect to the necessary breaks or resting-places, endeavouring to fix upon such natural breaks in the slopes as are in, or sufficiently near, the general line of ascent. When this has been effected, the exact angle of elevation or degree of steepness must be ascertained in the same manner in each rise or length of ascent between the breaks, &c. Hills are, however, in all cases, where possible, to be avoided.

Where communications are by means of roads to be formed with distant districts, care should be taken that they pass through such parts or places as may afford the greatest and most permanent advantages, without regarding in an improper degree the interest of individuals.

It is evident, therefore, that as much, in the proper performance of this business, must always depend upon the skill and judgment of the surveyor, he should, invariably, in finally deciding on a line of road, make himself fully acquainted with the nature, circumstances, and situation of the surrounding country, and attentively consider, after repeated examinations, which is, on the whole, the best and most advantageous direction to be fixed upon.

After having deliberately decided in regard to the line of direction, it will be proper, in the next place, to consider of the number of travelling parts of which it must consist, which must probably be different in different cases, and the form most suitable for its construction. With regard to the first, Mr. Marshall thinks that in all public roads there ought to be three divisions or parts for

for travelling upon:—a middle one of hard materials for carriages and horses in wet seasons; a soft one of the natural materials for use in dry weather, to save the other, as well as the feet of the animals; and a suitable path for the accommodation of passengers at all seasons. This is, however, seldom the case. The width of public roads should be according to circumstances, from thirty to fifty or sixty feet: and the widths of those of other sorts should be according to their *publicity*; but the above writer considers it the height of folly to make them wider in any case than their purposes demand. On the latter subject very different opinions are maintained. Some contend that roads should be convex; others that they should be concave; others, again, that they should be perfectly flat from one side to the other, and in the form of inclined planes longitudinally; and a few, that they should be perfectly flat in every direction. It is probable, however, that no one particular form is calculated to answer in, or suitable for, every situation; but that they ought to be varied according to the particular circumstances and situations of the country through which the road is to pass, and the use to which it is to be applied.

The convex or rounded form of roads is, in general, perhaps, by much the best, and certainly the most common; but the degrees of convexity are very uncertain and indeterminate, depending for the most part on the caprice of the person employed in the making of them. In some cases, however, they are considerably too much rounded, so as in particular instances to be very inconvenient, and even dangerous to the traveller. The adoption of this rounded mode of making roads seems to have proceeded on the supposition that water would be more readily conveyed off into the ditches or drains on the sides: but this is not exactly the fact; for much of the water is obviously detained on the surfaces of such roads by the tracks, irregularities, and roughnesses, produced by the impressions of the wheels of carts and other similar causes; which by thus stagnating, and being agitated and wrought up by the frequent passing of carriages and other heavy machines, soon renders the roads uneven, full of depressions, and almost impassable. The convex method of constructing roads does not, therefore, effectually prevent water from resting upon their surfaces. But, besides this, there are other disadvantages attending this form of roads;—the unequal pressure which the wheels of carriages must have in such cases, not only tends very much to break up and destroy the roads, but at the same time renders travelling on them very inconvenient and unpleasant, especially where the convexity is great.

Mr. Marshall has found such roads as appear to have the most desirable form, to rise in the crown or middle above the base line about ten inches where they were twenty feet in width, or an inch in every foot on each side.

With the mode of forming and constructing these kinds of roads in the first instance a late writer also finds great fault, conceiving it highly disadvantageous and absurd. The improprieties complained of in the methods of preparing such roads for the reception of the hard and more solid parts of the materials are represented in the section of a road so formed, which may be seen in plate LXIX. in

which fig. 2. shows the usual manner of forming a convex road: *a* and *b* exhibit the ditches or drains on the sides; *c c* foot-ways, or horse-roads when sufficiently wide; *d e* a convex line, ten or twelve inches lower at *d* and *e* than the foot-way. The space shown by the dotted line is to be filled up with hard materials. When thus prepared and made up, it is supposed, that though it may be imagined that the whole of the water that falls on the road may be conveyed away by the ditches or drains on the sides, yet, if it be examined in a wet season, it will, it is asserted, be found that, in general, however great the convexity may be, the water will stand, as has been observed above, in the various ruts and depressions that may have been made on it, particularly where the road has been so long made use of as to have worn down and reduced the stony materials on the surface, and forced up the moist earthy substance through them; and that if the road has been recently made or repaired, and the materials are of so porous a nature as to let the water pass through them, it will then lodge in the hollows on the convex retentive stratum below the hard materials, especially at the sides, when obstructed by the foot-ways, by which the bed or foundation of the road is kept constantly wet, and thereby quickly becomes out of order. By this constant stagnation of water below, too, the hard materials sink down into the soft earthy bed below, which works up through them, and causes all the dirtiness observable on the surface of them in bad weather, notwithstanding the thickness of the covering of hard materials may, at first, have been ten or twelve inches. Even where the under-drains are formed for taking off the water below the foot ways, at very short distances, this is not, it is thought, prevented; as the intermediate spaces quickly become so impervious, that the moisture does not pass through them to such drains; but the wet earth below is converted into a kind of *puddle*, similar to that made use of in preventing the entrance of water in different ground works, by which it is forced up, and stands in the depressions on the surface. But there is, it is said, another method of forming this kind of roads which has been lately described and recommended, in which it is proposed to leave a hollow, or vacuum as it is termed, in the middle, in which the solid materials are to be placed. Fig. 3. exhibits the plan of forming them on this principle; *a* is the hollow in which the hard materials are deposited, the bottom of which is flat instead of being convex, as in the former method, and of greater depth, consequently requiring a larger proportion of materials. The sole difference between this and that which has been mentioned above seems, it is said, to be, that, instead of the bottom of the hollow being made convex, it is formed more flat and deeper. It is, therefore, supposed that it is liable to the same objections that have been made to the first in a stronger degree; and besides, that it requires a greater thickness of hard expensive materials, which must be of the greatest depth in the middle or part where the slightest impressions are made, and the least injury done by the wheels of carriages or other causes.

In the above respect it appears that roads formed on the model of a gently-inclined plane have an obvious advantage; for the very ruts which the wheels make serve as channels to conduct the water

down the descent; at the lowest point of which a transverse groove should be kept open to convey it into the ditches on either side. So extremely gentle is the *necessary* descent, that grooves at the distance of one hundred and fifty yards will be found in most cases sufficient. The water has thus seventy-five yards to run, and the elevation need not be above eighteen inches, or two feet. It is commonly to be observed, that the convexity of a road is inversely proportioned to its narrowness. Turnpike roads of the full statute width, unless unusually shadowed by trees, receive so much sun and air, that they are kept toletably dry without much convexity of their surface. Narrow roads and lanes are only to be kept dry by artificial means, and sometimes the convexity is so extremely great as to render the passing of two loaded carriages extremely dangerous. Perhaps the general convex shape is preferrable for turnpikes; but the shape of the longitudinal-inclined plane has many advantages in narrow lanes, &c.

The objections, especially to the first form, when fully considered, will not, however, probably be found to be either so forcible or so generally applicable as the author seems to suppose them; as it is easy to perceive that the convex or rounded basis on which the hard materials rest may, in a great number of cases, be highly porous, and capable of admitting the water that may come upon it from the surface of the road, through the stony or gravelly materials, to percolate and pass through it to the drains which are prepared for taking it away; or even, in some instances, it may sink quite down into the loose porous bed itself, and in this way keep the road perfectly dry. It is, therefore, only where the basis or foundation of the road on which the hard materials are to be deposited, whether it be of a convex or hollow form, is composed of a retentive or impervious material, such as clay, that such objections can have any weight; and even in such cases, the ingenuity of expert road-makers frequently prevents the injurious effects that are apprehended from taking place, by providing a *substratum* of some sort of porous or penetrable materials, for placing the stone, gravel, or other hard substances upon, that may be employed in forming the upper part of the road. If the loose penetrable substances made use of in this way be laid of a sufficient thickness, and in a proper form in respect to the drains, there can be little doubt but that roads even when formed in a retentive soil may be kept perfectly dry, and free from the stagnation of moisture below them. Loose sand, the scrapings of old roads, and many other substances, that can in many situations be procured in large quantities and with great facility, may be used with success for the purpose.

Concave roads are formed in an exactly opposite manner to those of the rounded or convex kind, having the greatest depression and flatness in the middle, where they are the highest and most round. The sides of these roads are generally made with a small inclination, while the middle part is formed either quite flat, or with a very slight degree of concavity, and a small descent forwards is given them where necessary, in order to carry off the water to outlets constructed for the purpose. This sort of fall is formed at a trifling

expense, by raising some parts and lowering others. A spirit-level should be employed in the business when necessary, and where the fall is gentle the inclined plane can scarcely be too long.

In most situations, too, to make these roads sound, a good ditch must be made on each side, a foot or more deeper than the middle of them; and it adds to their safety if these ditches be made on the field side of the roads; or, where they are sufficiently wide, firm earthy ribs three feet in height may be left on the sides of the ditches. The leading consideration in constructing roads in this way is, that wherever water flows upon a road, that part of it, if the bottom be sound, is, it is said, for the most part, found the firmest and least destroyed. But roads made on this plan ought at first to be well set out and formed, and have the materials laid on true. All springs and dribblings of water should, likewise, be effectually cut off and prevented from running on them; for if these circumstances be not closely attended to, they seldom answer well.

At fig. 4. is shown a cross section of a concave road, in which the whole breadth *a e* of it is divided into three equal portions, as *a b*, *b d*, and *d e*, the sides *a b* and *d e* being formed quite flat, but the part *b d* has a gradual slight descent each way to *c*, the middle of the road; it has also a slight descent in a longitudinal direction for conveying off the water at proper outlets; *b d* the place in which the hardest materials are laid. In this form of road there are three parts on which carriages can go, as *a b*, *d e*, and *b d*, in which the horse-track is at *c*.

The advantages attending this form of road are stated to be these: that there are three parts on which carriages may be driven, without having any improper inclination or undue pressure on any of their wheels; by which means the draught is more easy to the horses, while the roads are more equally worn, and, in consequence of that, much less injury done to them.

Besides, they do not tear so much as is supposed by heavy rains, and are kept in repair with much greater ease. In some instances, too, the washings of such roads may, it is conceived, be usefully turned upon grass lands.

However much this form of road may vary from those which are in general use, it has been contended for by some very intelligent advocates, as the late Mr. Bakewell and Mr. Wilkes; and different roads in Leicestershire have been formed on the plan, it is asserted, with great advantage, both in respect to the roads themselves and the cheapness of their being kept in repair *.

* The directions of Mr. Wilkes, as stated in an ingenious paper in the First Volume of Communications to the Board of Agriculture, are that

When the fall is one foot in 150, or 200 feet forward, the fall from the sides towards the middle ought to be 15 inches in 20 feet.

When One foot in 100, to 150, to be 12 inches.
One foot in 40 to 100, to be 10 inches.
One foot in 30 or less, to be even the whole breadth.

Where the width of a road is 60 feet:
One foot of fall to each 40 feet in length of the road.
Twenty feet from the sides towards the middle, to have 9 inches of fall;
The inner 20 feet to be flat.

Those who are in favour of *flat roads with longitudinal slopes*, in the manner of very acute inclined planes, contend that, by being flat and level from side to side, the effect or pressure of wheel-carriages must be more equally exerted, and the friction less; while every part of the road may be made use of with equal facility and ease; that of course the wear will be more equal, and the road be easier kept in order, and with a smaller quantity of materials. To some it may appear, and probably is, a difficult point to keep such roads sufficiently dry; it has, however, been already noticed, that the impressions caused by the wheels of carriages detain the water on the rounded or convex roads, and prevent it from passing off at the sides; it may follow, then, that as this form of road is intended to have in level parts very gentle slopes, such as the fall of one foot in fifty, for the conveying off of the water, these ruts or depressions may serve as conductors, and thereby promote the passing off of the water into the lower parts of the slopes, whence it is conveyed away by the side drains. On this ground, it is supposed that this form of road may be kept clean and dry with greater ease than those of the rounded or convex kind.

The last form of road to be noticed is that which is *quite flat in every direction.* This is supported on nearly the same grounds as the above; only it is contended, that as there are few situations so very level for any length that water will not run one way or the other, it is quite useless and unnecessary to be at the trouble of forming slopes or inclined planes, but that suitable outlets should constantly be provided at every hollow part for taking off and conveying away the water; that, should the road in any part be perfectly level, shallow cross drains, which it is supposed will occasion no interruption to carriages, should be formed at every fifty or sixty yards, or nearer, if requisite, by which the road may be kept sufficiently dry and in order.

From these accounts and details of the different forms of making roads, it is evident that there are two principal objects to be aimed at in the business: 1st. That of constructing them so as to render them as free of moisture as possible at all seasons; 2d. That that kind of construction be given them which is most calculated to lessen the draught at the easiest expense. These probably embrace all the necessaries for forming perfect roads, but the difficulty depends on obtaining them in the completest manner; several modes of doing which have been just described, and may be had recourse to according to the particular circumstances of the different cases.

The author of a valuable communication on the subject of roads has proposed a new theory of constructing them, which, he says, is founded on nature. It is well known that some of the *strata* that are found in the bowels of the earth are of so close and dense a texture as not to admit moisture to penetrate them; while others are so open and porous that they readily permit water to pass through them in every direction, until it meets with some obstruction, or finds a channel to convey it off. Among these different *strata* there is also much difference in respect to their density and porosity; and in proportion as they partake more or less of these

qualities, they admit moisture to transude through them with greater or less facility. In further illustration of his ideas, and in applying these principles in the construction of roads, it is observed, that, supposing the section of a hill or eminence composed of a number of *strata*; if the uppermost *stratum* or surface soil be of a porous nature, it is obvious that any water falling upon it must pass through to the next *stratum* underneath, where, if it cannot penetrate any further, it must glide along the surface till it finds an outlet or vent at the bottom of the eminence. If, however, the second stratum should be hollow for some distance, the water will lodge in that hollow, and constitute a kind of pool or bog, as is often noticed on the tops of hills; but if in this hollow place there be a communication with the third stratum, which is porous, no water will stagnate there, but will pass through and run along the fourth *stratum*, which is dense, until it issues at the side or bottom of the hill. It is further evident, that if the first or uppermost *stratum* should be of a dense texture, as clay, any water coming upon it will not only stagnate in the large hollows, but in all the smaller ones, as well as in the other irregularities and depressions that may be on its surface. It is, therefore, clear, it is conceived, that in order to keep the surface of such a piece of ground as that described dry, it is not of much consequence what shape or form the surface has, whether it be convex or flat, so that there be a communication with an under *stratum* sufficiently porous to carry away the water below: it is, however, of much consequence that the form of the upper surface of that *stratum* on which the water is to glide should be smooth and even, in order that it may the more readily pass off. This will probably be better understood by consulting the section to which it relates, in the above plate, in which fig. 1. represents the stratified nature of the earth in the section of a hill or elevated ground, as 1, 2, 3, 4, &c. 1. The upper porous *stratum*. 2. The retentive *stratum* below, which confines the water until discharged at *b*: if the *stratum* 2 be hollow at *a*, and proceeds towards *f*, it then lodges in that hollow, forming soft ground there; but if at this hollow a communication is formed with the *stratum* 3, which is porous at *a*, no water will stand there, but penetrate through it to the impervious *stratum* 4, on which it glides till it finds vent on the side or bottom of the hill. If the upper *stratum* 1 be retentive, water falling on it will not only lodge in the large hollow *a*, but also in the small ones *c d e*, &c.

The application of this reasoning, in the formation of roads, is as follows: "Where a new road is to be formed, let it," says the author, "be done in the first instance nearly in the usual manner, with such materials as are on the spot, and the nearer the quality of these approaches to clay, so much the better. Instead, however, of forming it convex, as is generally done, it should be quite straight on each side, and meet in an angle or ridge in the middle of the road, having a slope from thence to each side of about an inch in a foot, and small drains at these parts, for the more easily conducting away the water that may be collected at those places. The road being thus formed must," he says, "be allowed to harden and settle

for some time, before any other materials are laid on; great care must be taken, while in that state, to let no carriages or cattle upon it, and it should be rolled with a long wooden roller that will reach at once nearly over one side of the road. This roller should be loaded with a box of stones to make it sufficiently heavy, and that it may be the more portable when that box is taken off; and it may be so contrived that, by changing the horses from one side to the other, there will be no occasion to turn the roller in order to make it roll the same space over again. Being rolled in this manner will consolidate the materials composing the ridge, and prepare it for receiving those to come afterwards; for it is a most absurd practice to lay hard materials, in the common way, upon the first form or basis of a road, before it is sufficiently firm to bear them.

"Being thus formed and properly settled, the next step to be taken is," he thinks, "to imitate the works of nature in dry soils as much as possible, by forming a *stratum* penetrable by water, composed either of sand or sandy gravel, or any other substance easiest to be got, that is sufficiently porous to admit water to pass through it. This *stratum* should be laid quite level, and extending from one side of the road to the other, filling up also the small drains on the sides, as may be readily seen by referring to fig. 5. which represents the mode of forming roads on this plan: the lines *a b* and *b c*, instead of being convex, are quite straight, meeting in an angle or ridge at *b*, sloping to each side regularly about an inch in a foot: *a* and *c*, small drains for conveying off the water collected at these places. Over this are to be laid the best materials that can be got for completing the road, consisting either of stones broken very small, or of the best gravel. This coat of hard materials need not," he supposes, "exceed above six or seven inches in thickness, which being much less than is commonly used, will be a considerable saving: and it may even still be less," he thinks, "if the directions hereafter given are strictly attended to. If this covering consist of broken stones, they should afterwards be laid over with sand or fine gravel, when easily procured, so as to fill up all the cavities betwixt them. The sand or rubbish from a free-stone quarry is excellent for this purpose, provided there is no mixture of earth in it, which should be carefully guarded against in every step taken after the road is first formed. These finishing materials being properly laid on and smoothed with a rake, the whole should now," he says, "before any carriages or horses are admitted upon it, be well rolled with a heavy iron roller, divided in three parts," as represented in the Plate on Rollers. The writer also suggests "that it would save much expense in repairing roads, especially new ones, if rollers of this kind were more generally employed, as it cannot be supposed that they will immediately bear wheel-carriages, or remain long in repair, when composed entirely of loose materials, unless some pains be taken to consolidate them. Rolling would of course, it is supposed, produce the most advantageous and useful effects, and tend very greatly to keep the roads in an even state, and free from deep ruts and hollows; and that nothing could conduce more fully or more effectu-

ally to produce and preserve firmness, without which it is utterly impossible to have good roads."

The advantages of having a road laid out and constructed in this way are said by the author to be these: "that, by having a level surface, every part is convenient and suitable for carriages, and will, of course, be equally made use of; from which the deep ruts, so common in other roads, will, in a great measure, be prevented. It will on this account also be much easier kept in repair; and, if well managed at first, will be constructed at less expense than by the common modes of making roads, especially in sandy soils, or where sand or gravel can be procured with facility. On such a road the draught too will be considerably easier.

Sometimes it will be requisite, it is supposed, to have cross drains of proper sizes carried under the fences from the small side drains mentioned above, at the distance of every ten or fifteen yards, where the level of the ground will admit of them.

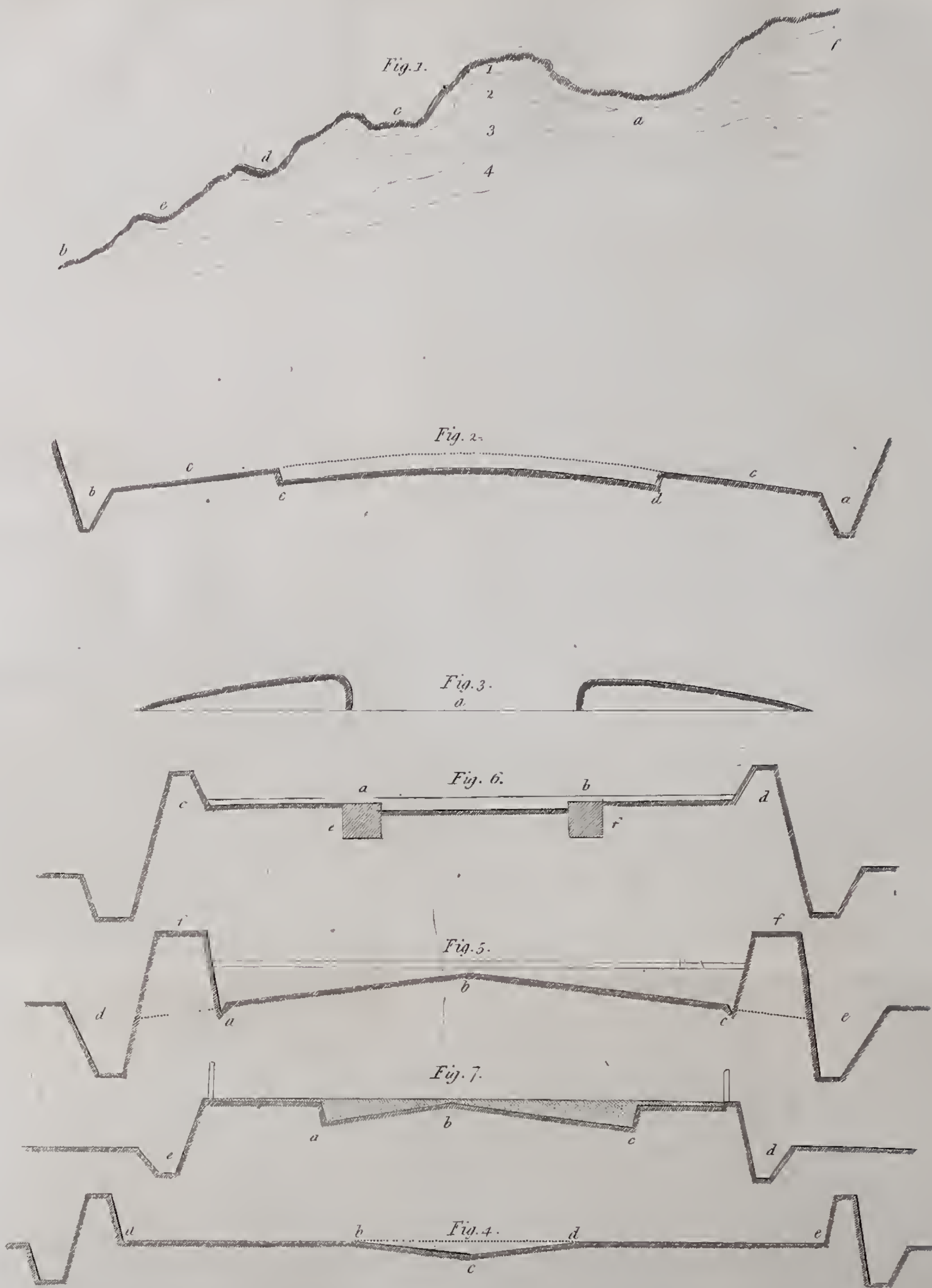
It is to be particularly noticed, that on all sloping roads on a declivity, where the water is apt, in heavy rains, to run upon the surface or at the sides, it ought never to be suffered to pass in the same direction more than ten or fifteen yards, but at such distances to be conducted away to the main drains, at the sides. By this means it will do little harm, as it can never increase to more than a weak stream; but if it be permitted to run one or two hundred yards, it will probably be swelled to such a size before it passes off as to wash away much of the materials, and do considerable damage to the road or fences on the sides of it.

It is, however, observed by an experienced rural œconomist, that the cases where it would be necessary to carry off the water every ten or fifteen yards must be extremely rare; perhaps there are few such cases. It has been observed, that "a carriage might almost as well be floating on a billow at sea, as tossing up and down on an inclined plane every ten or fifteen yards. When a road is constructed on the principal of the plane, there should be no sloping of the sides, otherwise the water is impelled by two forces at right angles with each other, and consequently tends in a diagonal line."

When made on this construction, the ingenious author supposes that roads need not be quite so wide as they are in common, as the whole surface of them from side to side will be in use. From twenty to twenty-four four feet wide, he thinks, will be sufficient; except it be in the vicinity of large and populous towns, or near extensive works where a great number of carts or other carriages are employed, in which situations they may with propriety be made much wider, as from thirty to forty, or even fifty feet. In the interior parts of the country, twenty feet in width will, indeed, answer every purpose. It has been observed in many places where the roads have not been more than eighteen or twenty feet wide, and properly made from side to side, that they were in much better condition than the neighbouring ones, which were from thirty to forty or fifty feet in width. On these wide roads, formed in the common way, there is, it is observed, seldom more than eight or ten feet in the middle of them

Pl. LXIX. 8°.

CONSTRUCTION OF ROADS



generally made; the remainder on each side being taken up with heaps of stones, scrapings, and rubbish of other kinds, which, though they may be sometimes wanted in repairing the roads, should not be suffered to remain in such situations, as they may be dangerous for horses and carriages in the dark. Besides, much valuable land is, he thinks, lost to the community*, and considerable injury frequently done to the farmer, by the seeds of noxious weeds which are suffered to ripen and be disseminated from such situations.

The difference of soils makes considerable difference in the construction of roads. Where the soil is of the sandy kind, roads may be made with great facility on the plan just described; as there will be little more to do than level the surface properly, fill up the different hollow places, roll it very well with the long wooden roller, and lay on such materials as are intended to finish it with, in the manner that has been already described; and afterwards roll it very well with the heavy iron roller. But if the soil consist solely of a deep loose sand, the best and easiest method of making a lasting road is to construct it to the intended width for the hard materials, at the sides of which channels should be dug eighteen or twenty inches in depth, and about the same width; these must be filled and firmly built up with strong turf or clay, or any other solid substance that will prevent the materials to be laid on the road from spreading to either side, openings being left at every ten or fifteen yards to let the water falling on the middle part of the road pass through more readily. But where the nature of the ground is such as to require to be made up, a small wall of the same materials must be built on each side, instead of the channels, nearly of the same height as the surface of the road is to be. By this means the hard materials which are laid on will be prevented from spreading, which is the chief reason of roads in such soils so suddenly giving way; and these materials will not be so apt to sink down into the sand, especially if it have been well rolled before their application, and at times after it has been finally completed. At fig. 6. in plate LXIX. is the representation of the plan of a road made in a loose sandy soil. After forming it to the full width for the hard materials, dig channels, *a* and *b*, where necessary at each side, 18 inches in depth, with the same width, filling them up with solid materials, as shown at *e* and *f*, to prevent the others from spreading out laterally.

If materials can be readily procured to cover the road from side to side, and it have a fence at each side, the walls will not, it is remarked, be so necessary, as they are principally intended to keep the

* The mode of calculation by which he attempts to show the quantity of land thus lost is this: "Suppose," says he, "the medium necessary width of roads to be seven yards, or twenty-one feet, and that the medium width now made is eleven yards, or thirty-three feet; this is, upon that supposition, four yards wider than is necessary, which in every mile is a loss of one acre one rood and two perches: and supposing there are 5,000 miles of such roads in the whole kingdom, there is s loss of more than 6,300 acres; which, if estimated the same as the improved value of the waste lands, at 27*s*. per acre, and at thirty years' purchase, would produce 255,150l.: a sum which, if laid out in improving the roads and making easy communications through different parts of the kingdom, would," he thinks, "be of the greatest public advantage."

solid materials together, where they are not to be applied the whole breadth of the road. Should these small walls, however, be found necessary, the spaces at the sides, by being coated with gravel or free-stone sand, will make good foot-paths.

In clayey soils the roads are, it is observed, for the most part extremely bad and disagreeable; and principally for this reason, that proper steps are not taken to guard against water stagnating on their surfaces. This may, indeed, occasionally arise from the want of materials, such as sand and gravel, though it is is far from being commonly the case. It is remarked, in the valuable paper just quoted, that "it seems hardly ever to have occurred to those who have had the direction of such roads, that *sand*, properly applied, would, in a great measure, remedy all the defects complained of;" and there are very few districts of a country, it is added, in which some sort of sand, free-stone, rock, or sandy gravel, may not be obtained by proper exertions, though in some situations it may be procured with greater expense and difficulty than in others. But where no hard materials at all can be had, if the roads were formed in a similar way to those we have described above, the inconveniences attending them would most probably be readily removed. The clayey foundation should be pared away in such a manner as to form a ridge in the middle of the basis or bottom part; and slight openings or drains be made at every ten or fifteen yards, or at such places as are hollow, in order to conduct off the moisture into the principal drains. The foundation, thus prepared, being then filled up with sand, or some other porous substance easily procured, and finished in the way that has been already mentioned, a good road may be formed. The manner of effecting this business may probably, however, be better understood by consulting the plate in which fig. 7. shows at *a b c* the clay hollowed out for the porous materials, so as to leave a ridge in the middle of it; the dotted lines, *e a* and *c d*, drains to conduct away the water at short distances into the main drains *d* and *e*.

In making roads through bogs or morasses, the first thing to be done is to drain or draw off as much of the stagnate water as possible, which may often be best accomplished by cutting ditches or drains of sufficient depth on the inside of the fences, where they are inclosed, or designed to be inclosed, on the sides. For this purpose, such drains should, however, be formed a considerable time before any thing further is attempted. Twelve or sixteen months, according to the state and circumstances of the cases, are probably little enough, as the ground, if very boggy, will settle very much after the water is taken off, and in some parts probably more than others, as the soil is more or less mossy or retentive of water. These will, therefore, be better discovered by such a delay, in order to their being filled up and levelled, which is readiest done by the materials cut from off the elevations, or such other substances as are near at hand. But in whatever way this is done, the surface sods should be carefully pared off, both from the elevations and hollows, by a suitable instrument, such as a paring-spade, and laid aside until the hollows and depressions are filled up and quite levelled, they should then be laid on again, by which means the whole surface will be rendered

not only level but of an equal degree of toughness, which is a point of considerable importance.

After these preparatory steps have been taken, the breadth of the part designed for the reception of the hard materials is to be marked out, and covered with sand, or such other porous substances as have been mentioned, to the thickness of ten or twelve inches at least. This should then be well rolled, and finished in the way that has been already described. If this plan be strictly adhered to, there can be little doubt of making good roads, even on mossy or boggy soils.

Other methods of making roads through these soils are, however, sometimes practised; as by laying a foundation of broom, furze, heath, willow, or other materials of the same kind, and then placing the hard materials upon them; but sand or some other porous hard material is always to be preferred, where it can be readily obtained, and where the line of the road is rendered properly dry before the materials are laid on; as woody substances soon begin to decay, and consequently let down such materials as are placed upon them, and thus quickly render the whole of the business to be performed over again.

In constructing roads in all kinds of soil the same rules and directions that have been given above must be attended to, only varying them according to the nature of the materials that are to be employed, and such local circumstances as may have any influence.

When roads are to be cut or formed on the declivities of hills, there are a few circumstances to be attended to, in addition to those which have been spoken of in constructing roads where the ground is nearly on a plain or level from side to side. It not unfrequently happens in these cases, that the part to be hollowed out and removed affords a sufficient body of materials for making the road, and the parts from whence they are removed seldom require any covering to be placed upon them. This, however, must be regulated by the nature of the soil and solidity of the bottom which is thus left. Where the whole breadth of the road is made from the solid, and that has a sufficient degree of hardness, no extraneous materials whatever will be requisite; but in cases where the soil is a compound of clay and gravel; or, where it is of a very soft earthy nature, an application of the principles and directions which have been already advanced will be necessary in forming it.

Where the lower part of the road is to be made up from that which is to be removed from the upper, it should be constructed considerably higher at first than the proper level, or bottom of that part from which the materials are taken, in order to allow for the settling, which may be much hastened by rolling; but the hard materials should on no account be laid on before this has been well accomplished.

Where the eminence is of much height above the road, the fall of water is sometimes considerable. In general, it is the best method, in these cases, to stop the water at a short distance from the road-side, and thereby prevent it from running down the face of the bank; for, if it be permitted to trickle down in this manner, it will quick-

ly, by means of frosts and other causes, destroy the bank, and choke up the drains, whether they be open or covered ones: if covered, the earth which is constantly mouldering down from such causes will soon become so close and compact, that the water cannot pass through it into the drain before it runs off upon the road; and if open, they are kept clear with great trouble and difficulty. But by stopping the water about five or six feet from the bank, and drawing it away to a proper outlet, the road may be kept dry with greater certainty and ease. Should the face of the bank have any irregularities, the water, in such cases, may be taken away by having the drain to recede from the bank in such places, and keeping the course constantly on a due level; or the same purpose might be obtained by letting it be taken off in the hollows, by means of small recesses faced up with stone, or by spouts made of wood and set upright in the bank at these hollow places, and communicating with covered cross drains under the road.

In plate LXX. at fig. 1. is shown the manner of constructing roads in these situations, in which *d c* is the part cut out of the solid, which in most cases will require no covering; *d e* the part made up, which at first should be higher than the other; *b c* the face of the bank: the water from above should be intercepted at *b*, to prevent its being injured and the drain *c* being choked up. In irregular-faced banks it may sometimes be necessary to let off the water by wooden spouts sunk upright in the banks at the hollows, as seen at *a b*, fig. 2.

In laying out and constructing these, as well as all other kinds of roads, it is likewise observed, that care should constantly be taken that no water runs upon them, except what falls in rain. But in cases where this cannot be easily prevented, and where a stream of water must of necessity run on the side of a road, the drains or ditches, which as has already been observed are the best on the inside of the fences, must be made of such dimensions as are sufficient to take the water that may come into them at different seasons. Those small drains, filled with sand or gravel, which have been spoken of above, are only suitable for such roads as cannot have any superabundant quantity of water at any time coming upon them.

That roads may be constructed in the ridge or sloping form that has been described above, with much propriety and success, in various situations, there cannot be much doubt; though experience, which is probably the best guide, would seem to show, that the slightly convex shape is not only more generally applicable, but that which admits of the materials being laid in the most advantageous manner, in respect to the pressure and wear of heavy carriages, as well as other points of importance. But, whichever form may be adopted, the road should never have much elevation in the middle, or be greatly rounded, only so much that the water may be well and easily taken off; as, where either the one or the other is the case, there must be great inequality produced in the pressure of carriages, by the weight being so much thrown on the lower wheel, and an increase of friction from the inside of that part of the wheel through which the axletree passes bearing too hard against the shoulder, and the outside too much on the pin which confines it in its situation; by which the dif-

Implements for repairing Roads.

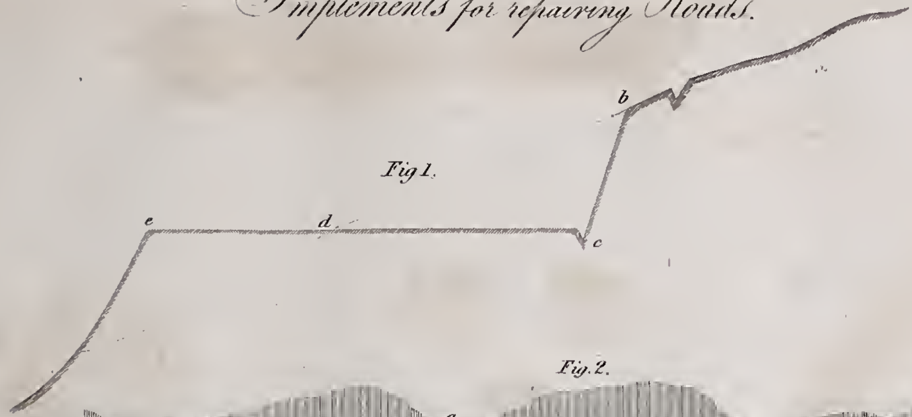


Fig 1.

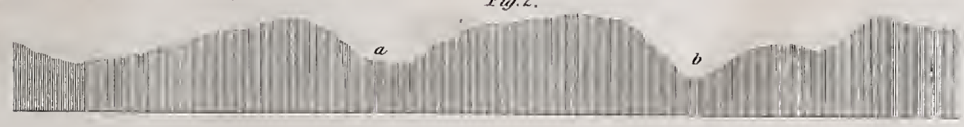


Fig. 2.

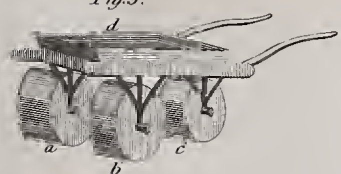


Fig. 3.

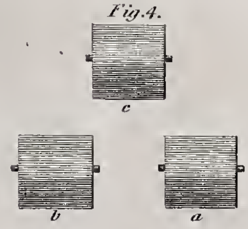


Fig. 4.

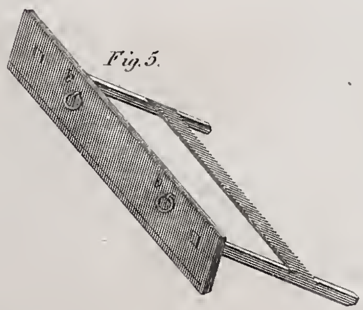


Fig. 5.

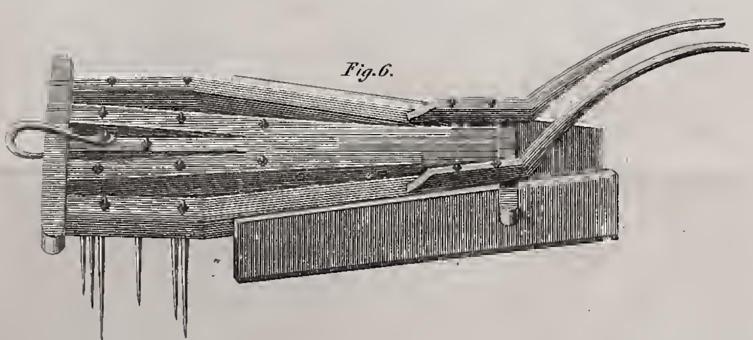


Fig. 6.

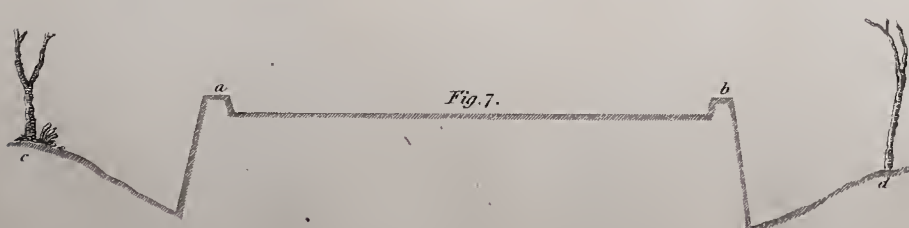


Fig. 7.

ficulty of the draught is greatly augmented, and rendered more inconvenient for the animal. And further, accidents are more liable to take place in conveying top loads, or such substances as are of a liquid nature.

With respect to the forms and methods of constructing roads of the narrow private kind, it has been remarked that in such narrow spaces the wholly rounded or convex form cannot be easily preserved; as when thus raised it readily wears into a middle track and two wheel ruts with foul drains on each side of them, becoming in bad weather a dirty trough unfit for travelling upon in any way; while by adopting the shelving form, or that which has the half-barrelled shape, not only a greater width will be obtained for travelling upon, and such ruts be less liable to be formed, but, the whole of the water from rains being thrown to one side, the other will afford a good path for walking upon at all seasons or periods of the year. When in such cases water in a wet season is liable to ooze out of the banks on the upper side of the roads, a narrow channel must be cut to prevent its overflowing them; or, in constructing them, it is suggested that the beds for the materials may have their inclinations in some instances reversed, so that the drains may be thrown on the sides whence the spring water proceeds, and by such means the same drains be made to answer both for the spring and rain waters.

It is also further conceived, that such semi-convex forms may be applicable not only to these narrow roads, but to those conducted in side-long directions on the sides of hills; as, by adopting this form, the whole of the water that falls upon them will be discharged without inconvenience or expense, and at the same time the beds be made narrower than in cases of the full convex form; which in particular instances may be a great saving. The higher sides of such roads, from their being nearly level and firm to the foot of the steep, would, it is supposed, be chosen by such carriages as are ascending; while the lower more loose surfaces would be used by those that descend, and the raised foot-paths on the lower verge afford good safeguards.

In the forming of private roads where the materials are of a strong binding quality, it is advised that the cavities for the reception of such materials should be made a foot or more in depth, either by digging out and removing the natural surface to such depth, or by only digging out half the depth, and placing the removed earthy material on the sides, so as to form a hollow to the same depth. In either mode, the hard materials must be afterwards deposited in the hollows so formed, being laid so as to leave the surface of the roads in a convex or semi-convex form, according to the turn and nature of the surface of the sites; the side or sides at which the rain-water is to be collected and discharged being left a few inches below that of the adjoining sward or other natural surface.

But in constructing them with loose incoherent materials that are absorbent, such excavations are to be avoided as wholly improper, such substance being best laid on upon level or rather elevated surfaces, shallow drains being opened on the sides for the absorbed waters being discharged by.

It is remarked, that such roads as are formed of such materials as bind strongly, when much used, have the surfaces in a very little time in a state to repel the water that falls upon them, whatever the nature of the basis on which they are laid may be, if it be sufficiently sound and firm for supporting them. In such cases, one or more deep ditches or drains should be opened at a little distance from the borders of the hard materials, to render the base firm, proper walking-paths being made between the roads and drains, with suitable channels cut across them.

Where the situations are dry, as on gravelly or stony heights, little more is often required than merely to remove the surface mould and expose the hard body of materials below, afterwards giving them a rounded or shelving form, according to the natural situation of the ground. In this way, it is conceived, "a travelable road may be made, and kept up, at one tenth of the expense incurred by the ordinary practice in this case; which is to gather up the surface soil into a ridge, and on this soft spongy bed to lay coat after coat of some hard materials, fetched perhaps from a distance."

With regard to the constructing of carriage-tracks, which are often a sort of by-roads necessary on light calcareous hilly situations as well as where the surfaces are of a sandy nature, they mostly consist of merely three narrow lines of hard materials, two of them sustaining the wheels, while the third or middle part receives the animals which are employed in drawing the burthen. In cases of this sort, where the sub-soils are of a soft nature, all that is requisite in the forming of such roads is that of preparing three lines of hard artificial sub soil, by digging out the soft materials, in the lines answering to the size of the carriages, and afterwards filling them up within a few inches of the natural level of the surface with suitable hard materials. It is remarked by Mr. Marshall, that "the use of having the surface of the hard materials lower than the general surface of the ground, and with lines of sward rising between them, is to guide the animals of draught, and thereby keep the wheels in their proper track. Therefore, where the line is straight, the horse-path ought to be exactly in the middle between the wheel tracks. But where the road winds, and most especially at a quick bend, the horse track ought ever to incline towards the outer side of the curve; as by this means the wheels will be uniformly kept on the middle parts of the supports prepared for them. Hence it is advisable to dig the trench for the horse-path first, and to draw a carriage for which the road is intended with the horses walking in this middle trench; thus marking out, by the impressions of the wheels, the precise middle lines of the outer trenches in every part of the road from end to end." And "it may likewise be useful, he thinks, as a practical hint, to suggest, that, in depositing the hard materials, the largest and roughest are to be thrown to the bottoms of the wheel trenches, as foundations for the hardest, which ought to receive the immediate pressure of the wheels; the softest and finest being disposed of in the middle track. This requisite separation is easily made by a judicious workman in carrying on the work of filling the trenches. Where narrow-wheeled carriages are in use, the sur-

faces of the wheel-tracks should be made dishing, and the hard materials be broken small in the trenches with heavy hammers; thus consolidating the whole mass, as well as preparing the surface for the reception of the wheels. For broad wheels less care is required, they are consequently more eligible for giving firmness to a newly made road." It is added that " carriage tracks of considerable length have been formed for narrow wheels, which run four feet nine inches from middle to middle of the fellies, by the following dimensions: the middle trench twenty-one inches wide, and ten inches deep; the outer trenches fifteen inches wide at the top, and fourteen inches deep, narrowing to six inches wide at the bottom, thus leaving the two lines of green sward, where the roads run straight, ten inches and a half in width."

And it is stated that horse tracks may be readily constructed in this way at a small expense, and with almost any sort of materials that are firmer than common earths: where the situations admit, sand or any other similar loose absorbent material may be had recourse to for the purpose with propriety; proper drains being formed on the lower sides to admit the water which may have been absorbed to be readily discharged.

There is another method of constructing roads, which may be applicable in certain circumstances and particular situations. This is that of forming them of rails of wood or iron, of different sizes, according to the situation and weights that are to be carried, with grooves in them for the wheels to run in.* These are laid on a perfect level, and *inclined planes* formed where necessary, the ground being first formed true, and rendered dry by drains. By which, and the use of proper machinery, heavy carriages may be forced up or let down as the nature of the case may require. As roads of this kind are very liable to wear out where wood is employed, it is probably advisable, in most cases, to have them made of cast iron; and they should always be double, one being placed at a small distance from the other, having communications at such distances as may be convenient for the purpose of passing in either direction: where iron is used, it is by much the best way to have the rails secured in stone-work, as when prepared in this way it would be very little liable to be out of order. The carriages, of whatever kind, which are to travel on such roads, must be adapted to the purpose; the best general mode of constructing which, where heavy loads are to be carried, would probably be that of their having low iron wheels. The principal advantages of roads of this nature are, that great weights may be conveyed on them at little expense of team, while they do not cost much more in forming than well-made turnpike roads. Extensive roads on this plan are met with in different places, as near Coln-brook-dale in Shropshire, and at Orrel near Wigan, Lancashire, for the purpose of conveying coals, &c. Mr. Marshall also suggests, that they may be found useful for lime-works in many situations. It is

* When made of iron, from 20 to 40lbs. per yard is the usual weight: 33lbs. is sufficient for carrying two tons. A bar of bet-iron, one inch and a half in breadth and $\frac{5}{8}$ of an inch in thickness, is sometimes fixed on wooded sleepers for the same purpose.

probably in situations and for uses of this kind that such roads can be had recourse to with the most advantage, as by means of them the cutting up and destruction of other roads may be much lessened or wholly prevented.

Repairing Roads.—However common the practice may be for the surveyors, or overlookers of roads, to permit them to be much cut and broken up before any effectual means are employed in repairing them, it is certainly extremely injudicious and expensive; as experience has fully shown, that it is much the most œconomical plan to never allow them to get out of repair to any considerable degree, but to preserve them in as even and level a state as possible. Where circumstances will admit of it, the best, and probably the most saving method of proceeding is, that of having suitable experienced persons appointed in every township or district, or for a certain extent of road, for the express purpose of seeing what parts are in a bad condition, where water stagnates, or deep and improper ruts are formed, and to repair and remove them as expeditiously as possible.

In filling up and repairing the hollow parts, as well as the tracks which are formed by carriages, care should constantly be taken that all the water be previously well drained off, and the loose mud or earth effectually removed. In some cases, however, wheel-tracks may be restored to a proper state merely by the removal of their sides, without any filling up; but the substance thus removed is highly improper for being deposited in the ruts again, being of too soft and earthy a nature for such repairs. Indeed, the common practice of throwing down the sides of wheel-ruts in order to render them level, is but a very transitory and ineffectual repair. Suitable hard materials should always be had recourse to in such cases.

In constructing and repairing roads, it is also a circumstanc of more importance than is generally supposed, that the quality of the hard maserials should be as nearly equal as possible, and, where stones are employed, that they be broken down as much can be to an equality of size; for it is well known that where the size of the stones made use of is various and unequal, the road will wear in holes and uneven. This is sufficiently shown by what happens in a road where stones lie at or near the surface which are larger and of harder qualities than those of which the rest of the road is composed, as hollows or depressions are constantly produced by the opposite wheel to that which passes over such stones. This also affords a reason for removing every thing out of roads that has any tendency to throw carriages of any kind too much on one side, and for immediately filling up and repairing the parts of wheel-ruts which are more cut down on one side than the other.

Where gravel or ballast is employed, it should, likewise, be as equal as possible, and well freed from clay, and all sorts of earthy materials that it may contain. This separation might probably, in some cases, be greatly promoted by having the gravel dug in the autumn, and letting it be once or twice turned over during the winter, after having been thoroughly moistened, in order that it may be exposed to the action of the frosts, in a state the most suitable for being broken down and separated. In regard to the size of the ballast that

is made use of in repairing roads, though it is common to require it large, such as is of a middling equal size is, in general, to be preferred, as binding better and sooner on all roads.

In the winter season nothing should be done to roads in the way of repairs, except in cases of necessity, such as the restoring of places that may have suddenly given way, or been much cut up. The mud and stagnant water on the surface must, however, be constantly attended to and removed; and proper materials may, during this season, and especially when there is a hard frost, be collected and carted to such situations as may require them when the summer advances, which is the proper time for making and repairing roads. But in doing this, unless the repairs are to be immediately performed, suitable places should be provided for them, instead, as is the common practice, of depositing them in heaps on the sides of the roads.

About the latter end of March, or beginning of September, when such periods are sufficiently dry for the business, is by much the most proper for putting fresh materials upon roads, as they are then not prevented from binding or becoming firm, either by too great drought or too much wetness. In the first a moderate coat, where it is wanted, should be laid on, and in the latter a more full and complete one. But before any sort of material is applied, the road must be well scraped and cleaned, and the hollows and soft places, after being scooped out, and the bottoms well loosened, filled up level with good hard materials, rammed in by means of a heavy rammer. In this way such places are rendered as hard and firm as any other part of the road. In the application of the surface materials afterwards, great care should be taken that they be spread out as equally as possible over the whole.

By rolling with a heavy roller, as has been already noticed, much advantage may be derived in the reparation of roads, especially if the hard part of the materials thrown out by the pressure of wheel-carriages be restored previously to the operation of such a roller; as it can hardly be supposed that materials, however good, when put on in a loose manner, can remain in their situation, or be durable, though it is a practice too commonly followed by the overlookers of roads, who but seldom employ any kind of instrument for the purpose of consolidating the materials they apply in making repairs. If this mode was made use of at an early period, before any very large portion of the gravel or other matter was removed, in many cases no other means whatever would be necessary.

At fig. 3. in plate LXX. is represented an iron roller with three divisions for the purpose of rolling new formed roads; in which *a* and *b* show the two hind parts, and *c* the middle or front one to which the shafts are attached, and which are so constructed as to turn in the manner of the fore wheels of a waggon. *d* a box for containing stones to increase the weight occasionally; two-thirds being placed over *a* and *b*, and only one third over *c*, in order to make the pressure equal. And at fig. 4. the plan of the roller as standing on the surface of the road; *a* and *b* the back, and *c* the fore or middle part.

With a view to restore the stones, gravel, and other materials,

which may have been thrown up or displaced by the action of different kinds of wheel-carriages, implements of various sorts have been proposed; but the common rake and spade, in the hands of an expert labourer, are probably the best. The *road-harrow*, invented by Mr. Harriot, of Great Stainbridge in Essex, seems to answer pretty well where roads are repaired with small stones or gravel. The inventor asserts, that "a man, a boy, and two horses, will do three miles in length in one day, completely harrowing down the quarters, and drawing the stones together, which, by means of the mould-boards, are," he thinks, "dropped into the ruts far better than a man can stub them in."

At fig. 5. in plate is the representation of an implement for the purpose of levelling the surface of roads, which is used in America, according to the Bishop of Llandaff, for levelling ground. It is constructed of a strong plank, *a*, five or six feet long, shod with iron on the inferior part, which has a sharp edge for scraping the road as drawn upon it. A frame is fixed at the back of the board, on which the driver stands, directing the horse by two rings or hooks *b b*. And at fig. 6. is a harrow invented for this use. Its head is three feet in length from the outsides of the bars. The bars are four inches square and five feet in length. The mould-boards extend eleven inches further to draw the stones harrowed up nearer the middle of the road; and are four feet two inches long, ten inches in depth and two inches thick, shod with a bar of iron, and lined six inches with iron plate. The teeth are one foot in length from the under side of the bars, steeled at the point, and an inch and quarter square, fixed in with nuts and screws, having collars both above and below the bars. The bars pass in a longitudinal direction, to guard against splitting. It is drawn by two horses abreast, the outside horse on the outer quarter, and the other in the path, a man steadying the harrow by the handles. Thus an inside and outside quarter are taken in going, and the others in returning. It is suggested as an effective implement by Mr. Beatson.

Where such a machine can be used, the saving of expense may of course be very considerable. Rolling in the manner that has been already described should, however, constantly be had recourse to after the use of this harrow, in order to make good work, or render the road sufficiently firm and solid.

The clearing of public roads from mud, &c. has hitherto been attended with much labour and expense, especially in low flat situations; and various methods have been proposed at different times for effecting the purpose. An effective machine for this use has lately been invented by Doctor Winterbottom of Newbury, in Berkshire. With regard to the operations of this machine it is observed, in the Twenty-first Volume of the Transactions of the Society of Arts, two men and four horses are required; one man to drive the horses, and another to take the management of the pole and the direction of the labour to be performed. The horses are to be worked double, as commonly practised, two being employed to draw by the shafts, and two by the chain. One great advantage in the operation of this machine is, that by the use of it the road is

made more even and smooth, the small holes being filled up by the more solid parts of the mud; whereas when roads are scraped in the usual way, by hand, all the irregularities are increased, and become the future deposits of water; and it is universally known that these puddles, as they are called, are the chief cause of the destruction of roads. It has been observed, that stones are sometimes forced up by the machine; but it appears to be those only which project in such a degree as to be dangerous to the traveller, and which require to be broken for the more effectual mending of the road. Nothing concerning the effect of the machine upon dusty roads is stated by the inventor, not having had an opportunity of trying it at that season of the year. When, indeed, the roads are watered, as about London, "there is," he says, "no doubt but a great quantity of that dirt may be removed, which in a few hours of scorching sun would again be converted into a body of dust. If it should be objected, that the machine is too large, and that a smaller one, which might pass over half the space of ground that this does, and might be worked by two horses, would be better, the inventor thinks that with a less one there would be much labour to little purpose; because this machine, which passes over a space of about six feet and a half, will not in some places, when the roads are very wet and very deep, leave more than three feet clear, the mud on each side falling in and filling up to a considerable extent the space already passed over: it must therefore be obvious, that under similar circumstances the track of a smaller one would almost instantly be obliterated."

It is also added, that at first the general effects of the machine were such, that several persons of great experience in the management of roads rated the daily work of one machine only as equal to the labours of fifty or seventy men; fifty being the lowest estimate. Further trials have since, however, shown that one machine will clear three miles in one day twenty feet wide, consisting of four lengths, and making the day's work twelve miles; which is considerably more than 120 men can do in a day.

	£.	s.	d.
120 men, at 2s. per day - - - -	12	0	0
Four horses and two men can here (Newbury) be hired to work the machine for the day at - - -	1	15	0
Difference - - -	10	15	0

At a distance, where carriages run principally in the centre of the road, the chief business in the management of it consists in keeping the sides clear and open. One machine may therefore be occasionally employed in outside work only; that is, may go six miles, and return (making twelve miles as just mentioned), with the saving already given.

Additional trials have rendered the advantages of this machine still more evident.

It is recommended to make use of this machine, to be careful that it is well put together, especially in the braces behind. The scraper may be made of beech or elm, but the other parts of ash, the materials being well seasoned. The inventor's machines were constructed by Mr. Joseph Moss, of Greenham near Newbury. The cost is about ten guineas.

In making the repairs of roads, the choice of materials must chiefly depend on the facility of their being found, and the convenience of conveying them. On the principles which have been laid down it must be evident, that a good foundation for a road is a *stratum* of any porous substance, such as sand, or sandy gravel, or even the refuse of freestone quarries. The harder materials should be then applied, the best of which are stones broken very small and evenly, or gravel; and the more hard and brittle the stones are, the better. One load of stones prepared in this way is said to be more valuable in repairing roads, than three loads of such gravel as is taken from the beds of rivers or from commons, as it furnishes a firmer bottom, at the same time that the surface is more equal, uniform, and durable. Where other stones can be procured, those of a calcareous nature should, however, never be employed, as they soon moulder down, and undergo a sort of decomposition, by which a kind of clay is produced, that in wet seasons renders the roads extremely dirty, and causes them to retain water on their surfaces, which is prejudical in a very high degree. Where small stones are made use of as the finishing coat, they ought always to be thinly spread over with fine gravel or freestone sand, in order that the crevices may be well filled up, and the road be thereby rendered more durable.

Where roads are repaired with ballast, after the holes, tracks, and hollow places have been properly filled up, and the water well drained off, as already noticed, a slight covering, in places where it is wanted, after the foundation or ground has been well loosened at the bottom, should be applied at the times and in the manner stated above. If roads repaired by this substance be covered too soon in the year, it is, however, apt to be too much reduced before the winter sets in, which is the time they ought to be in a good and firm state.

In the forming and repairing of communication of parochial or private roads, attention should constantly be had to the different principles and circumstances which have been detailed in constructing those of a public nature. Under the present system of management in these cases, little improvement is, however, to be expected, as the means are far from being sufficient for the purpose, and those who have the temporary direction of them are seldom sufficiently well informed in respect to the nature and principles of constructing or repairing such roads, to perform the business to the greatest advantage. Indeed, until the very inadequate and inefficient plan of statute labour be completely done away, and a suitable equivalent in money raised, and at the same time persons of knowledge, experience, and information, with proper salaries, be appointed for managing the expenditure and application in such district, under the control of the acting magistrates for the time, or some such power, it is

almost utterly impossible that such roads can be either made or kept in a good state of repair.

But, whatever methods or plans may be thought the most advantageous and effectual in removing the inconveniences which have so long been complained of in the badness of parochial roads, it is obvious that, in addition to this, they must have considerable effect in improving the state of agriculture, by lessening the quantity and expense of labour, as well as by facilitating the means of conveying certain kinds of materials, without which the attempts of the farmer in carrying on improvements must often be very circumscribed and ineffectual.

In general, private or parochial roads are made so narrow as to admit of carriages passing one another with difficulty, except in particular places. They are also, in many instances, extremely circuitous and winding, by which much time is lost in the carting of materials. The side drains are seldom sufficiently opened and kept clear, on which account the roads suffer considerably; as from large quantities of water stagnating upon them, deep sloughs and ruts are readily formed.

Roads have been supposed to be subject to much injury and destruction from some particular forms of wheels: thus, broad ones, though conveying immense weights, have been recommended and encouraged, in preference to those of the narrow kind, which carry comparatively but a very light load. But it is not the breadth of the wheels which ought exclusively to be considered, but the form or construction of them, and the weight of load that is placed upon and carried by them; as it is clear, from the effects which are produced, that the materials of roads cannot be rolled down flat, or left in a perfectly solid state, by wheels proceeding in straight directions, except where they have a cylindrical form of rim, and do not convey very weighty roads. The wheels of waggons and other heavy carriages, though they have been required to have a certain breadth of rim, and a flat bearing on the road, have not been constructed in such a form as is best suited to consolidate, roll down, and keep the surface of roads in repair. The soles or rims of them, instead of being cylindrical, have mostly been the portion of a cone, the properties of which have lately, by various experiments, been shown to be those:—of their having a natural tendency, in rolling, to revolve in a circular direction round their conical centres; of their requiring a constant power or force to keep them to a straight line or course; in their being confined or compelled to move in such straight direction, a rubbing and friction occurring at the rim; their augmenting friction on the axis; their causing a rubbing against the sides of deep ruts or tracks; their throwing up dirt from the hind part of the wheel; their pulverizing and greatly reducing the best sort of materials in dry seasons, thereby causing much sludge in wet, and much dust in dry weather; their deranging and breaking the texture of the surface of the roads when in a soft and compressible state, and leaving them in a broken condition, ready to imbibe moisture, which causes all the bad effects of wet seasons and intense frosts; their promoting the destruction of paved roads, by forcing open the joints and letting in

the water under the stones, which by ultimately floating and discharging the gravel, renders the stones loose, and permits the pavement to sink into holes; their augmenting the labour of the cattle or team, and accelerating the wear of the tires of the wheels, by their constant tendency to drag and grind on the roads.

The cylindrical form of rims is shown to be free from these inconveniences, having a constant tendency to proceed in a straight direction, without friction or rubbing at the circumference, or against the sides of deep ruts; not throwing up dirt by the hind part of the wheel; not increasing friction on the axis; not having pressure against the linch pin; the sole obstacle to their proceeding in a straight line, arising from the compressing and levelling the materials over which they pass; have no disposition to displace or break up the texture, or prevent the consolidation of the parts of the roads on which they run; their frequent rolling on compressible substances rendering them more level, compact, and impenetrable to water, leaving them in a condition more favourable for consolidation; and by contributing to keep the *interior* and softer parts of the roads dry, they are more enabled to resist injury, and support the crust that is the protection of them; have not the effect of opening the joints in paved roads, but, on the contrary, to improve them by operating as a rammer on the stones over which they pass, from the *dead pressure* arising from the equal velocity of all the parts; and advancing in a *straight course* with the least possible resistance, and with greater advantages than any other shape,—serve equally to improve roads, relieve cattle and preserve the tires of wheels *.

* These being the different effects of the conical and cylindrical form of the rims of wheels on roads, it is obvious that the latter must be much more beneficial in preserving them than the former, and that the advantage gained by the use of them will be proportioned to the extent of the surface over which they roll. Taking the difference in the effects between the conical and cylindrical form of the rims of wheels at the rate of only one shilling for every acre of road rolled with the latter instead of the former, it is supposed by Mr. Cumming, that the probably amount of the advantage that may be thus obtained to the nation annually by the wheels of "such waggons only as travel the turnpike roads," would be as follows:

"The number of waggons in England is," he states, "upwards of 96,600: and supposing that a tenth only of that number be employed on the turnpike roads, and a fourth of that tenth, or a fortieth of the whole, have wheels twelve inches broad; and of the remaining three-fourths, that one-half have wheels six inches broad, and the other half, wheels only four inches; the statement of the whole will be this:

Number of waggons employed on the roads - - -		9,660
Waggons with 12-inch wheels - - - -	2415	
Ditto with 6-inch wheels - - -	3622½	
Ditto with 4-inch wheels - - -	3622½	
		9,660

"A wheel twelve inches broad will, in rolling thirty miles, cover a space of 158,400 feet; and the four wheels of a waggon rolling a double surface will, at the same rate, in a day's journey, roll a surface of 633,600 feet, which is equal to the whole surface of four miles of a road thirty feet wide, and something more than fourteen acres and a half; but rejecting fractions, and taking

The various facts, observations, and experiments, on which these very useful and interesting conclusions are founded, can only be well understood by consulting the valuable paper alluded to above; but the results of the different experiments are shown in one point of view, and so arranged in the following table, that those made under a similarity of circumstances, both with the conical and cylindrical wheels, may be easily brought into a state of comparison. Thus the first column, A, furnishes the number of each experiment, in the order in which they were made, for the purpose of referring to them when necessary. A description of the particular circumstance under which each experiment was attempted follows. The column B explains the number of weights which were required to draw the carriage under such a combination of circumstances, in such a manner as just to *begin its motion* without being assisted. And the last column, C, exhibits, on the scale of acceleration, the number of spaces that the carriage advances after the weights have ceased to act upon it;—which, it is observed, "by estimating each division on the scale as equal in the value to *one tenth of the weights that draw the carriage*, we ascertain how much the resistance to the progress of the carriage is less than the power by which it is drawn, *in decimals of that power*.

fourteen acres and a half as the quantity, the result in acres will be as follows:

2415 waggons, with 12-inch wheels, will, in a day's journey of thirty miles, roll - - -	35,012
3622 waggons, with 6-inch wheels, will roll - -	26,259
3622 waggons, with 4-inch wheels - - -	17,506
The number of acres rolled in a day by all the waggons -	78,777

"And supposing all the waggons, at an average, to travel only ninety days in the year, they will roll a surface equal to 7,089,930 acres; which, at one shilling per acre, will exceed *three hundred and fifty thousand pounds* per annum.

"But, waiving pecuniary estimates, let it," says he, "be remembered, that the quantity of surface that is rolled once yearly by the waggons that travel the roads of England, is equal to the *entire surface* of 1,948,880 miles of road thirty feet wide. It is surely then" he thinks, "of importance to inquire, whether the wheels that roll this very extensive surface tend to improve or impair it? It is to be observed that no notice is here taken of the waggons that are supposed to be employed for the purposes of agriculture, &c., nor of the immense number of carts, coaches, &c., that travel the public roads."

TABLE OF EXPERIMENTS.

A. Number of the experiments according to the order in which they were made.	The circumstances under which the experiments were made, with the different sets of wheels.	B. Number of weights required to make the carriage begin its motion.	C. Number of spaces which the carriage advances after the weights have ceased acting.
1st.	The Conical Wheels bearing on their whole breadth, were drawn by	9	$0\frac{1}{2}$
4th.	The Cylindrical Wheels, ditto, ditto - - - -	6	$3\frac{1}{2}$
2d.	The Conical Wheels bearing on a fourth of their breadth on the middle tire	6	1
5th.	The Cylindrical Wheels under the same circumstance - -	6	2
3d.	The Conical Wheels bearing on two slips on the extremities of their rims	11	0
6th.	The Cylindrical Wheels under the same circumstances - -	6	$2\frac{1}{2}$
7th.	The Conical Wheels drawn on friction bars, that remove the friction at the rim	6	$0\frac{1}{4}$
8th.	The Cylindrical Wheels on ditto, at liberty, but the friction bars do not move	6	1
9th.	The Conical Wheels on the friction bars (fixed, bearing on their whole breadth)	9	$0\frac{1}{3}$
10th.	The Cylindrical Wheels, ditto, ditto - - - -	6	$0\frac{2}{3}$

The following important deductions are drawn from a comparison of the effects of each class of wheels under similar experiments, as shown in the table: namely, that from "the *first* and *fourth* experiment," it seems evident that the same load that is drawn on *conical wheels* by a power of nine, is drawn on *cylindrical ones* by a power of six; and that after the power has done acting, the carriage with the former kind of wheels proceeds only one *half a space* on the

scale of acceleration; while that with the latter sort, though drawn by a third less power, has sufficient *motion* left to advance it forward *three spaces and a half*.

That by the *second* and *fifth*, it is clear that when the conical wheel is made to bear on a fourth part only of its breadth at the middle of the rim, it is drawn by a power of six, and proceeds *one space*, after the acting power ceases; but that cylindrical wheels bearing on the same breadth, and drawn by the *same power*, advance on the scale *two divisions and a half*; which shows that even the *narrow cylindrical* is drawn with more ease than the narrow conical wheel, and that the difference in favour of the former is, in this instance, equal to $\frac{3}{20}$ of the power by which the carriage is drawn. That the third experiment proves, that when the conical wheel bears equally on the opposite extremities of the rim, *eleven weights* are requisite to draw it; that, with this increased power, it stops the moment the action of the impelling weight ceases: the uniform resistance to its progress being equal to the uniform action of the power no residue of motion is left to force it forward. That the *sixth* evinces, that with the cylindrical wheels, bearing in a similar manner on the extremities of their rims, *the same load* is drawn by *six* weights only; and the motion so accelerated as to carry the carriage two spaces and a half forward, after the weights have ceased to act upon it.

That the result of all these experiments, on the whole, shows that the greater resistance which takes place with the broader conical wheels does not depend on the breadth of the rim alone, but upon the breadth and the conical shape conjointly. That, in conical wheels, the *increase of resistance* depends upon the difference of the velocity of the greatest and of the smallest parts of their circumference, and that the exertion of the cattle must necessarily increase in the same proportion. That the resistance is increased on the same conical wheel, when the pressure of the load is confined to those parts of the rims that have the greatest difference of velocity. That, on the same principle, the resistance with the conical wheel *on a hard bottom*, is diminished by narrowing its bearing; but that on yielding substances the effect is directly the contrary. That, since this friction and dragging of the conical rim is owing to the different velocities of the several parts of the circumference, it follows, that every wheel which has not an equal velocity in every part of its circumference, must have a dragging and unnecessary resistance; that is, a resistance that may be avoided by giving to every part of the circumference, or rim, the same degree of velocity. That the only means by which an equal degree of velocity can be obtained in every part of the circumference of a wheel is, by making all the parts exactly of the same diameter; and every wheel that has all its parts of the same diameter must necessarily be *cylindrical*. And thus, that the conclusions from the result of experiments, and from theory, concur in proving, that so far as regards the labour of cattle, or the facility of the progress of carriages, the cylindrical shape of a wheel is preferable to any other possible shape; and that this superiority of the cylindrical wheel, which has hitherto been illustrated by considering only the

causes from which the greater resistance with conical broad wheels arises, is further proved by the experiments that have been made with the cylindrical wheels; in each of which, *the same number of weights* were required to make the loaded carriage begin its motion under the same variety of circumstances, which with the conical wheels occasioned the difference shown in the table, in the number of the weights required to draw the same load; and the number of weights that were capable of drawing the loaded carriage under each of those various circumstances on the cylindrical wheels was only equal to the least that was required with the conical; and when the conical wheels bear on the extremities of their rims, five more weights are required with them than with the cylindrical wheels. And that although no difference appears by the number of weights required to begin the motion of the carriage with the cylindrical wheels, whether they bear on the whole breadth of the rim, on a narrow part of its middle, or on the extremities of the felloes; it seems clear by the spaces which the carriage advances, on the scale of acceleration, after the weights have done acting upon it, that when the cylindrical wheel bears on its whole breadth, it advanced on that scale $3\frac{1}{2}$ spaces; when bearing on one-third of its breadth only, it advanced only $2\frac{1}{2}$ spaces; and when bearing on a fourth of its breadth only, it advanced no more than 2 spaces: here then, it is observed, is seen a most important difference between the cylindrical and the conical wheel; namely, that *the broader the bearing of the cylindrical wheel*, the more easily it proceeds; and that the broader the bearing of the conical wheel, the greater is the resistance to its progression.

On these grounds and principles it is suggested, that the use of low broad cylindrical wheels, with light carts, may be advantageous for many purposes of the farmer, such as conveying manure on tillage and meadow land, in all kinds of seasons.

And the ingenious writer concludes that, on the whole, cylindrical wheels must therefore be beneficial to the proprietors of waggons, by their lessening the labour of the cattle on the *same road*, as well as keeping the roads in a more improved state of repair; and to the *trustees* of roads, by their improving them, and rendering less expense in repairs necessary, independent of the less injury done to the roads used by the farmer.

As the goodness of roads and the expenses of keeping them in repair are also considerably influenced by the nature of the fences that are made on the sides of them, it may not be improper to take notice of a few circumstances which respect them. In cases where the situation of the ground on the sides of roads is such as to allow of sunk fences being made, they are unquestionably the best, as they contribute much to the keeping of them dry. They may be constructed in the manner of open ditches or drains, and of suitable depths, the deepest parts being constantly on the side of the fields. But where they lie open to the roads, this can seldom be done with safety. By having the fences and ditches formed in this manner, the foundation of roads may be more easily kept free from moisture, and at the same time more space be allowed for travelling upon, than in cases

where the ditches are constructed on the sides of the roads. Where the fences are formed of stone or sod, or even of quicks, they ought not to be higher than two or three feet above the surface of the road; but if a paling be made use of, it may with advantage be set higher. By keeping the fences low, the roads will be more exposed to the action of the sun and wind, and consequently sooner rendered dry, and free from the stagnation of moisture. Wherever high hedges or trees grow on the sides of roads, they keep them constantly wet and dirty; the former, should, therefore, be cut to the height of five or six feet, and the latter be either pruned close to near the tops, or totally removed. Neither trees nor plantations of any sort should be planted so near the sides of roads as to prevent evaporation from rendering them quickly dry. Where trees are, however, to be planted in the neighbourhood of roads, the distance should seldom be less than ten or fifteen feet from the fence, and forty or more from each other; in which cases they must be protected while young from cattle, by hurdles, or a paling of some other kind.

The method of placing the trees in these cases is shown in plate LXX. at fig. 7. in which *a b* is the extent of the road; and *c d* the planted trees.

Embankments.—In many situations extensive tracts of land may be gained by the judicious construction of embankments. In improvements of this sort, the proper forming of the *banks* constitutes the principal difficulty and expense of the undertakings. The particular circumstances of the case must chiefly direct the operator in regard to the situation, size, and manner of construction, as well as the nature of the materials which are to be employed. In general, however, the situation of such banks should be such as that their bases or foundations may not be unnecessarily exposed to the direct action of waves or currents. Where the quantity of water is in some measure limited, as in the case of land-floods in particular instances, the greater the space it has left to extend itself in, the less height and strength will be requisite in the bank, and the force of the current be lessened in the same proportion. But where the courses are liable to be filled up by depositions, it should be recollected that the more the water is confined the stronger the current will be, and the less the danger of their filling up.

In regard to the line of an embankment, it should always be *even*, and as free from *irregularities* as possible, in order to occasion the least possible *resistance* to the currents of whatever kinds.

In forming the bank, the height and strength should constantly be made in proportion to the depth and weight of water that it may have to resist, always having the inner face made to incline towards it, for the purpose of support in the way of a buttress. The out-face must be formed in a sloping direction, so as to approach a degree of flatness, in order to obviate *resistance*, and lessen the *pressure* or *weight* of the water. On this being properly executed its firmness and durability greatly depend. In difficult cases, it is advised that the outer surface should form an angle to a perpendicular line of from forty-five to sixty degrees, according to the force to be opposed and the nature of the materials employed.

In respect to the materials, where the foundation is good, firm, and solid, and the bank can be constructed, at a suitable time, without much interruption from the water, the natural earth of the ground may answer perfectly for the body of the bank as well as the inner surface; and where the pressure of stagnant or almost still water is merely to be resisted, the outer slope may be formed of the same. But in cases where the force of either waves or currents operates directly upon the banks, the outer slopes should be well secured against it, with the best materials that can be conveniently provided, and the bases or foundations be properly secured from being undermined; piles, timber, and masonry being had recourse to where the foundations are not sufficiently firm and solid. It is of the utmost importance in these cases to guard against accidents.

Besides the construction of the banks, attention is also necessary to the forming of the discharging channels on the outsides of the embankments. The position of the mouth, or out-fall, should constantly be such as that the current of the receiving waters may not warp or fill them up, but tend to clear them out, and keep them free. They should likewise be situated as low as they can be conveniently permitted below the flood-gates of the banks, the better to induce currents, and thereby keep the flood-gates and the mouths of the channels the more free and open.

In cases of open seas or other extended waters without any discharging channels, but where the waves extend to the foot of the banks, two flood-gates may sometimes be necessary, one on the external side, to resist the force of the waves, and prevent their *blowing up* the works on the inside; the other on the inner side, to secure the passage more fully. Thus, when water is admitted by the outer flood-gate being lifted by the waves, its progress is effectually stopped by the inner valve being in a perfect state. Where the valves are liable to be choked up, from being situated below the surface of sand or other shifting banks through which the water forces its way, and are only capable of being kept clear by constant trouble and expense, the remedy in difficult cases of this nature, is that of defending the discharging flood-gates by *covered* channels carried out into the sea through the line of beach, made sufficiently strong to resist the force of the waves. This is, however, an expensive method, and should of course be avoided when possible. In all cases where external valves or gates are required, and liable to be filled up, great care must be taken to keep them open and free, either by piles, fences, or other contrivances, run out in such a manner from the embankments as not to interrupt the discharging water, the earthy materials collected by its being occasionally removed.

In these cases, common *hinge flood-gates* may be the most proper, or such as swing outward, and fall into a rabbetted frame. They should be always made of seasoned oak timber; being made double, by the different planks crossing each other, in order to prevent their warping. They should be so contrived as to fit pretty tight, without being liable to stick by swelling. This is effected by the edges being made to slant or bevel inwards. The frame should likewise incline a little inward, but not so much as to retard the exit of the

contained water. Where rivers or streams pass through embanked grounds, the sides may frequently require to be raised sufficiently to prevent their overflowing in times of floods. And where they are too low to be fully drained, it may be necessary to form embanked channels or cuts for receiving the water when thrown up by machinery. These embanked channels may be converted to various uses, such as irrigation, &c. in different cases.

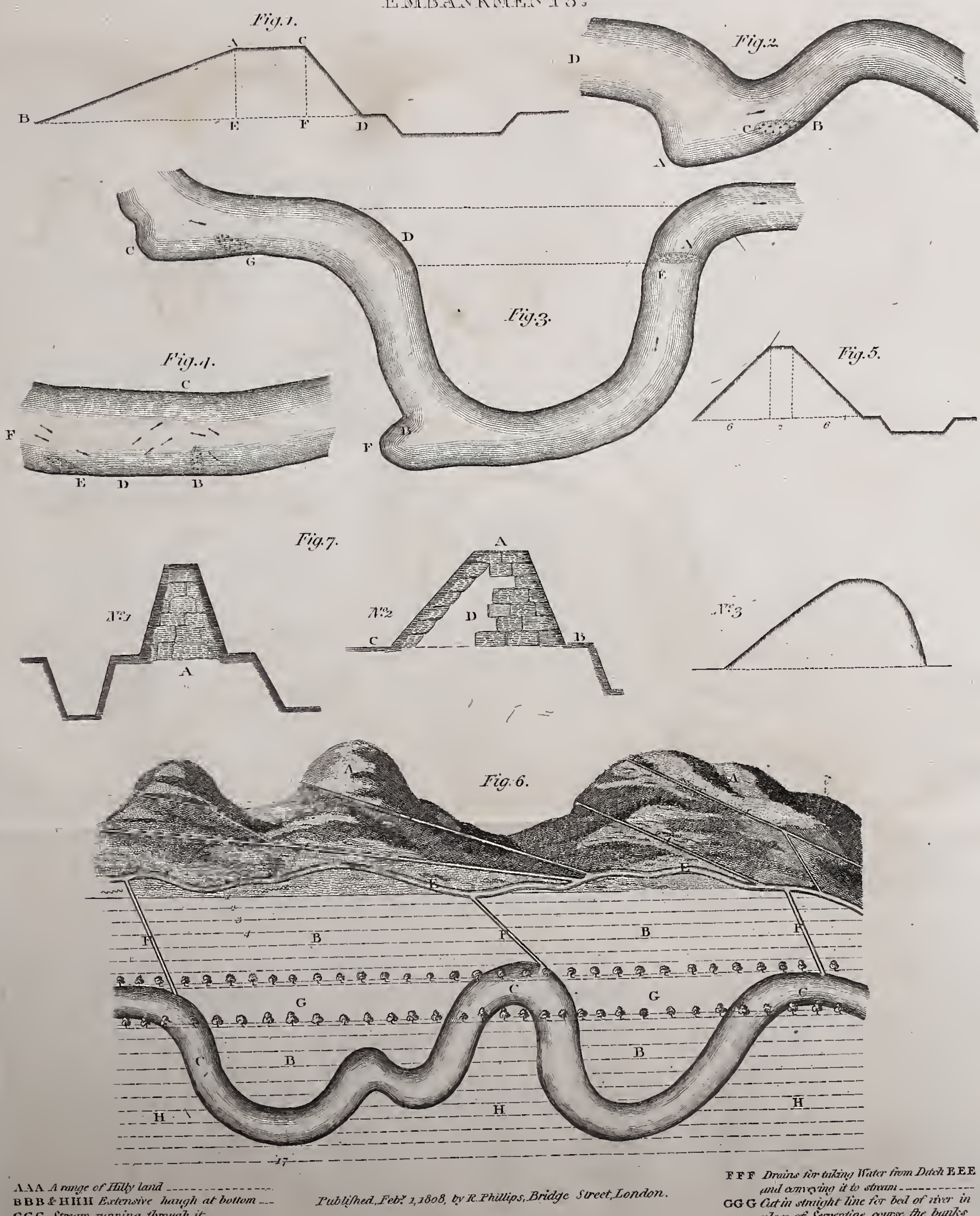
Embankments have been divided into three different kinds; as those against the sea, against rivers, and against lakes, each of which should be formed according as the resistances require. The first, however, in general requires by far the strongest and most expensive works.

In embanking against the encroachments of the sea, it should first "be considered what is the greatest depth of water at the highest spring-tides. About two feet higher than that should be the summit of the bank. Some have recommended only one foot higher, but it is best to err on the safe side; for the consequences attending an overflow after the whole is completed, may, in one tide, do a great deal more damage than all the expense of the additional foot in height. If the embankment be made at first even three feet higher than the highest rise of the tide, especially at those places exposed to the waves or swell of the sea, it will be so much the more secure, for new works of this kind always subside or settle in some degree after they are erected. It is a very necessary precaution, particularly if the banks are large, to take the levels frequently for some time after they are completed, lest they should subside too much, and thereby occasion a mischief which it was imagined had been sufficiently guarded against. If the banks are but low, this precaution is not so necessary, for the settling will always be more or less according to their height, and in low banks will be but very little. It is hardly possible to give one general rule respecting the size and dimensions of such embankments. This must be regulated according to circumstances and situation, for which a skilful engineer will always make the proper allowances. If the embankment to be made is to exclude the sea from a low marshy piece of ground, over which it flows only at spring-tides, the operation is easy, and may be effected at a small expense. If it is intended to reclaim a piece of land that is covered every tide, either in some bay or creek, or on the sides or windings of some large river in which the tide ebbs and flows, the work will be somewhat more difficult, in proportion to the depth of the water and the rapidity of the current. If it is proposed to exclude the sea from some exposed situation, either at the mouth of a river, or in a bay or inlet uncovered every tide, the work will be the most difficult and most expensive of all, in proportion to its exposure to prevailing winds and to the depth of water to be resisted. Each of these situations requires a different mode of management. Embanking against the sea, if at any considerable distance within high water mark, is not only the most tedious, but the most difficult of all; for, if the materials are not very good, and the work is not properly performed, the force of the water at every flowing of the tide will soon undo all that has been done, especially if the soil is of a sandy nature, as it

often is in such situations. If it is a strong clay, as is sometimes the case in marshy places, there will be the less risk of its being washed away. In sandy situations it has by some been recommended to lay bundles of straw or reeds well fastened down, or any other impediment, to prevent the soil from being carried away, by the ebbing tide. Where a sufficient quantity of good strong turf cannot be had, then expedients may be tried; but where such turf is to be got, as in most marshy situations, and where the embankment required is not to exceed the height of four or five feet, it is best to finish the slope with good turf as expeditiously as possible as the embankment proceeds; that is, supposing a length of thirty, forty, or fifty feet or yards of it can be completed in a tide, it is better to finish that length to its intended height, than to trace out or begin a greater extent than can be finished before the tide returns, by which a great deal of the soil might be carried away, and much of the work demolished, which is not so likely to be the case when the slope is finished. Turf, containing the roots of bent or rushes, is very good for this purpose. The first thing, however, to be done in an embankment of this sort is, to stake out the intended line of it, marking the breadth at the base, also the width at the excavation, or trench, to be made in the inside, from which most of the materials that compose the bank are to be taken; this trench also serves as a drain to keep dry the grounds within. At different parts of it should be trunks, or sluices, to shut of themselves against any external water, and to open, when the tide ebbs, to let out any water from within. Its width must be proportioned to the quantity of materials required from it for the embankment—eight, ten, or fifteen feet wide, and three or four feet deep, leaving a *berme*, or space between the edge of the trench and inner bottom of the embankment. If the soil is strong, one foot or eighteen inches will be sufficient for this *berme*; if it is loose or sandy, it will require at least three or four feet.

The more gradual and easy the external slope is made, the resistance against the sea will of course be the less sudden, and the embankments less liable to injury: this slope must therefore be made according to its exposure to the winds and tides; but nothing can be a greater error than to make it too bold or upright. See plate LXXI. fig. 1. "The inside slope should be also faced with turf, which may be laid with the green side downwards, as in building any common sod wall. Some expert sodders can finish this kind of work extremely neat, by setting the sod on edge, according to the slope intended to be given, and with proper mallets and beetles ramming the earth hard behind; which consolidates the work as it advances, and tends very much to its durability. When the first or lower course is finished, they pare the upper edge of the sods with a sharp knife quite even, by laying a rule to them; and then they go on with the second course, which they finish in the same manner, and so proceed till the whole height is completed; which, when finished properly, looks very beautiful and smooth, not a joint between the turfs being seen. If turf is to be used in covering the outside slope, it must all be laid with the grass uppermost, and well beaten down with a flat sod beetle, for that purpose; and for their better security, it may not be amiss to drive a small stake of about eighteen inches long or more through every sod,

EMBANKMENTS.



AAA A range of Hilly land

BBB & HHH Extensive haugh at bottom

CCC Stream running through it

dddd Open drains cut sloping towards them

EEE Ditch at bottom of declivity for receiving Water from drains dddd

FFF Drains for taking Water from Ditch EEE and conveying it to stream

GGG Cut in straight line for bed of river in place of Serpentine course the banks planted with trees

1 2 3 4 to 17 Ridges parallel to cut GGG

Published, Febr. 1, 1808, by R. Phillips, Bridge Street, London.

The sods for this purpose should at first be carefully taken up and traced by a line, all of the same breadth, and their edgest cut as even as possible, that they may make the closer joints; which will tend very much to their security till they grow properly together. In laying the different courses of these sods, care should likewise be taken that the joints of the one are covered by the other, in the way that good brick-work is made."

If it be proposed to reclaim a piece of land upon which the sea ebbs and flows every tide to a greater depth than in the foregoing case, as in a creek, or on the side of a large river, a different mode of proceeding, it is observed, must be adopted according to the soil and to the materials intended to be used. "If there are plenty of stones to be easily had, a bulwark may be formed of these with a mixture of clay, either by land-carriage, or (which in some cases is preferable) by carrying them in flat-bottomed boats, or punts, and throwing them overboard till a bank is accumulated. If stones cannot so easily be had, a quantity of clay, or other materials fit for the purpose, thrown in the same manner, may answer equally well. It is supposed that most of the embankments in Holland were done in this manner, by carrying the clay dug out of the canals in boats, and throwing it into the water. In either case it is necessary to fix up strong poles before the work is begun, as guides for laying down the materials. Sluices are also requisite at certain places to let out the back water when the tide ebbs; but the position and construction of these depend so much on local circumstances, that the engineer who conducts the work ought to be the best judge where and how to form them. A great deal depends on a skilful engineer in works of this kind, who will contrive many ways to facilitate the work, and to overcome all difficulties in the execution of it."

The following "species of sea-embankment is perhaps the most important of any; for there are few estuaries, or mouths of rivers, where large and valuable tracts of land may not be gained by such means. The shoals, or flats, formed at the entrance of such rivers are often composed of the richest manures or most fertilising particles, brought down by the stream from the towns above, or from the adjacent country through which the river flows. These shoals may therefore, by proper management, be in general very easily converted into the most fertile plains. Where such a situation happens, the first object is to collect the whole river into one stream, and to prevent its overspreading a wider extent than just sufficient for its discharge; or, perhaps, it may be better to alter the course of the river altogether, and to make it discharge itself at some other place. The principle upon which that idea is founded is this:—It has been observed, and proved by experience, that if the course of a river or stream be altered in such a manner as to make it discharge itself into the sea at a different place than it did before, the former place will in a few years, by the constant accumulation of sand or mud brought in every tide, be so choaked up or raised above its former level, as to form of itself, in process of time, a bank, that with a very little assistance will quite exclude the sea; for, as the current of the river before carried away all that sediment which the motion of the waves naturally stirred up, the current being removed, all or

most of the muddiness will not only be carried further up the old channel of the river, but a great part of it be deposited there as the tide recedes. It has even been observed, that in spring-tides and particular winds this sediment is deposited in greater quantities than at other times; and Mr. Beatson has been informed that, on making a perpendicular cut in the land so gained, the different strata or layers were so distinct, that those made at spring-tides could easily be distinguished from the rest. This is a very curious fact, and well worth the attention of all who have lands situated at the mouths of rivers, as there may, in many such places, be considerable tracts gained in this manner at a very small expense. Although this fact may be proved by experience in some places, nevertheless he should imagine the effect would not be the same in all situations. Where there is a great extent of flat or muddy shores, the motion of the waves will no doubt stir up the mud or sand, and carry great quantities of them along with the current on the flowing of the tide; and when the tide ebbs, although some of the lighter particles will be carried away again, yet it is natural to suppose the heavier ones will be left behind. If the shores are bold and rocky, except just near the entrance of the river, there will be the less of this mud; but, indeed, on such shores there can be little or no occasion for embanking, unless perhaps in some creeks narrow at the entrance and spreading wide above. From such creeks, if the sea were excluded, a great deal of land might probably be gained."

It is remarked, that "embankments against rivers may be divided into two sorts; namely, those for preventing their encroaching on the adjacent lands, and for protecting those lands and the neighbouring level country from being overflown when the water rises above its ordinary level. It may be observed, that where the course of a river is a straight line, or nearly so, it hardly ever makes any encroachment upon its banks, unless, perhaps, in very large rivers, when they rise above their common level either owing to an increase in the waters, or to their being in some degree affected by the tides. In either case, the waves occasioned by a strong wind, where the river is wide, will moulder away the banks on that side upon which it blows, unless prevented in proper time. This may be done either by securing the bank properly with stones, or by driving a row of long piles pretty close together, at a little distance from the shore; the piles being of such a length, and so driven, that their tops may be always above the highest rise of the water. It is surprising the effect that piles driven in this manner have in resisting the power of waves. Some years ago, when on duty as an engineer at a fort near Portsmouth, built on a point of land much exposed to the sea, the waves made such havoc that the walls on that side were constantly giving way, although built in the most substantial manner, and having bulwarks of large heavy stone besides to protect the foundation: however, all would not do; those bulwarks were soon knocked to pieces, and several times the wall itself. At length it was proposed to drive a number of piles about forty to fifty yards from the fort. Those piles were twelve or fifteen inches in diameter, and driven about one diameter from each other, nearly in a straight line, parallel to the wall where the waves did so much damage. They were driven

into the ground with a pile-engine till perfectly firm, perhaps eight or nine feet deep, and about two feet of the top of them left above the level of high-water mark. After this was done the walls received no further injury, the space between the piles and the fort being always perfectly smooth however tempestuous the waves might be without. The same simple method might sometimes, perhaps, protect the banks of large rivers exposed to the waves when other methods fail." But "the most common cause of rivers' encroaching on their banks is, the resistance occasioned by a sudden bend. In flat countries apt sometimes to be overflown, where there are any such bends or windings in the rivers, it would be of great advantage to straighten the course as much as possible; for, as every impediment or obstruction will naturally cause the water to rise higher than it otherwise would do, and as such bends have that effect, consequently in the time of a flood the waters will overflow a greater extent of country, and to a greater depth, than if the river had a free and uninterrupted course straight forward. If the windings of the river cannot be altered, and encroachments are making on some part of the banks, it must first be considered whether the force of the water can be diverted to another place where no injury can be done." See plate 71. fig 2. On the river Nith, in Dumfriesshire, it is observed, "a good deal has been done in this way by Mr. Miller, of Dalswinton. See fig. 3. As the river was encroaching most rapidly, and seemed inclined to take a new course, which would have destroyed some very fine land, and done a great deal of mischief in that part of the country;—to prevent this, Mr. Miller made a large cut about four hundred yards in length, and threw in a great quantity of stones quite across the river to direct its course in a straight line. This had in a great measure the desired effect, by totally preventing its progress; but now it began to encroach on its banks at another part. He at first endeavoured to prevent this, by driving in, at a considerable expense, a number of piles at a little distance from the bank, and wattled them with willows, branches, &c. thinking thereby to protect the bank. The piles were drove in by heavy mallets, apparently firm into the ground; they continued so for some months, till a heavy fall of rain came on, which swelled the river, undermined the piles, and carried them all away. But it is in vain to think of piles doing any good in such a situation unless firmly driven in by a pile-engine, for it is not possible to drive them in properly with mallets. This must have been the cause of their giving way so very soon. The piles not succeeding, he was resolved to try another plan. Several of his adjacent fields being covered with an immense quantity of stones, he ordered them to be gathered and thrown into the river, so as to form a jutty a little way above the injured bank. Being obliged to go from home about that time, and leave the execution of the work to some country people, they carried out this jutty too much at right angles with the stream; it had not therefore the desired effect, but rather made the matter worse than before; for, if a jutty is carried out at right angles, the current will be forced to the opposite side of the river, and thence it will rebound more violently than it did before. But if a jutty is placed obliquely, it will force the current gradually on the other side, in

which position one jutty may do more good than several placed improperly at right angles. See fig. 4. He was therefore under the necessity of making other jutties in this way, and has now the satisfaction to find that they answer the purpose intended. Those he made laterally formed a sort of convex slope, the convexity being parallel to the current. Strong planks were also firmly set on edge among the stones, their ends pointing towards the river; so that, if ever any current came so rapid as to move any of the stones, it must move them all of a body the whole length of the plank. Perhaps this precaution was unnecessary; for although stones are thrown into a river loose in this manner, the slush, sand, &c., that come down the river, will fill up all the cavities, and render it as firm and solid as a regular-built wall."

"The next sort of embankments against rivers are, it is observed, those to prevent them overflowing their banks, and inundating large tracts of country. This may be considered as the simplest and easiest of all sorts of embanking, if judiciously executed. It is therefore the more inexcusable to see in some places extensive tracts of the richest meadows completely overflown by every flood. Few ordinary-sized rivers rise more, even in the greatest floods, than five or six feet above their common level, unless when they meet with some considerable interruption or confinement in their course. But, if interrupted or confined, they will rise perhaps twenty feet or more, If, for example, a given quantity of water is six feet deep when running over a space of twenty feet wide, it is clear, if that space were made only ten feet wide, the water would rise to twelve feet; and if it were made forty feet wide, the same quantity of water would rise only to the height of three feet. It is therefore of great consequence, in preventing inundations, to give the river as much width as possible, by widening every narrow place. All kinds of obstructions should also be removed, whether occasioned by windings, shoals, stones, trees, bushes, or any thing else. In some cases this may even preclude the necessity of embanking; but where embanking is necessary, let the banks by all means be at a sufficient distance from each other to contain with ease between them the largest contents of the river in great floods. The distance and height of the banks may easily be ascertained by measuring a section of the river when at its highest, or when the flood-mark is visible. Where a sufficient distance is allowed between the embankments, their height need not exceed from four to six feet. If irremovable obstacles are in the way, which cause the river to rise higher, the banks must be higher in proportion. In either case, however, the slope of these kinds of banks on each side may be equal to its perpendicular height, and the breadth on the top about one-third of that height; so that, supposing the bank six feet high, the base would be fourteen feet, and the breadth of the top two feet. See fig. 5. The materials for making these banks should be taken as much as possible from the sides of the river, which will have the double effect of widening the river and forming the embankments; and there should be a trench on the inside (from which materials may also be got), with some sluices, as formerly directed, to drain off any water from within; also sluices to let in water from the river, if required,

which would very much fertilise the meadows if properly laid out for that purpose."

Farms situated on the borders of rivers are often liable to injury and inconvenience from them in different ways; as from part of the soil being carried away in times of flood, from the rivers overflowing their banks, and from the rivers in times of flood flowing back into the channels of the rivulets and streams that conduct the water from the more elevated and distant grounds to the rivers, whereby these rivulets and streams are made also to overflow their banks. The danger of the soil being carried away in time of floods is increased or decreased according to circumstances; as the form of the banks, the nature of the soil, the rapidity of the river, and the quantity of the water that lodges on the margins of the banks, or falls over them into the river. Where the banks of a river are perpendicular, if the soil be of a sandy or rich mouldering nature, the danger of part of them being carried away by floods is greater than where they slope gently from the surface of the field to the bed of the river; which when they do not, they should be made so. But if the soil and subsoil be an entire mass of clay or strong loam, and the current of the river do not press more on one part than another, a substantial improvement may be effected by sloping the bank so that the declivity may be one foot in three or four from the surface of the field to the bed of the river. And where gravel mixed with small stones can be conveniently procured, spreading these materials on the sloping bank, to the depth of eight or ten inches beyond the flowings of the river, may prove a good security against further damage; and if the bank be planted thickly with any sort of willow, it will in a short time become an impenetrable fence, and the annual cuttings of wood soon be equal to the value of the land thus occupied. Where no gravel can be procured, the new sloped bank should be immediately covered with well swarded turf, which should be beaten down as hard as possible, either by the back of the spade or with wooden mallets. If this be done in the beginning of summer, and willows be planted the following autumn, the improvement may be effectual and permanent. In order to prevent the effects of a current against a particular part of the bank, a fence or bulwark of stone in the front of the place may be necessary; the best way of doing which is, to drop the stones in a careless manner, but so as they may lie close together on the sloped bank, care being taken to lay them all the way from the bed of the river till considerably beyond where the river flows in common. In level, or nearly level districts, all that is necessary is to secure full scope for the rivers to overflow their usual bounds without interruption: when that is secured by either of the methods before mentioned, floods, unless very violent, seldom do any material damage to the banks of rivers in such situations. It is in many cases extremely difficult to guard rapid running rivers in such a manner as to prevent part of the banks from being carried away by inundations. Neither sloping the banks, nor strong bulwarks made of stone, would here be effectual: the method of filling a sort of large open baskets, placed along the bottom of the banks, with stones, has been found successful;

and as these baskets may be made to contain two or three tons of stones, it can only be on few occasions, and in very particular situations, that they can be displaced or carried away.

Where the water coming from the hills or high lands is considerable, and the courses of the rivers extremely serpentine, so as to produce much injury on the flat lands below by the stagnation that is produced, advantage may be derived in other ways; as by straightening the course of the rivers, and interrupting the water coming from the high lands above them, by cutting proper drains and channels along the face of the declivity as shown at fig. 6.

In embanking against lakes, it is observed that "as the waters subside greatly in the summer season, and rise considerably in winter, or when the season is wet, advantage may in some cases be taken to confine them within their summer limits, or at least to cut off some of their branches or creeks When either of these is to be attempted, the principal outlet must first be examined, and that should be enlarged and widened considerably; which, upon the same principle as already mentioned respecting the widening of rivers, will prevent the water rising so high as formerly. If the levels will not admit of much depth being got, or if the ground is rocky, and would be difficult and expensive to deepen, let the breadth be increased as much as possible, and every obstacle cleared away, that the water may run freely into a shallow stream. If it is required to ascertain exactly or to fix the future limits of the water, a section of the greatest quantity running out during a flood should be taken. Suppose this section, for example, ten feet wide and four feet deep; by making it 40 feet wide, the same quantity of water will not rise above one foot: consequently, by this means alone, three feet in height will be gained all round the lake, which, in case of embanking it, would be a very great object." The summer season is the best time to carry on these as well as other embankments; but when materials are to be brought from a distance, they may be laid down or prepared at other seasons, excepting the turf, which should always be used as soon as possible after it is cut. The manner of constructing embankments of this nature is the same as in other cases.

The methods employed in making embankments against the sea on the estate of Lord Galloway are represented at fig. 7, by Nos. 1, 2, 3. They were formed to the heights of three and a half and five feet, having the breadths of six feet, and five feet at the bases, and 20 inches at the tops. They were constructed almost wholly of turfs or sods, with only a little well beaten stuff in the middle of one of them; and with two small drains, one on each side, about two feet in depth, cost about 3*d*. per yard. In executing all sorts of embankments, the greatest care should be taken to make them perfectly firm and water-tight, by constantly beating and ramming them well while they are forming.

On the nature of guarding river-banks in different situations and circumstances, a variety of useful practical directions and observations may be seen in Mr. Marshall's work on the landed property of England; as well as the best means of effecting the business in different cases and situations, illustrated by figures.

THE FARMER'S COMPANION.

PART THE SECOND.

SOILS, MANURES;

DRAINING, PARING, BURNING, AND FALLOWING.

SECTION VI.

Soils.

THE particles of the various solid, as well as less compact, bodies that are met with in nature, and which have been rubbed down and reduced by the successive operations of the atmosphere, and the agency of other natural causes, being mixed and blended together in different ways and proportions, constitute the earthy compounds, which, from their being capable of absorbing, and in some measure retaining, moisture, as well as giving stability, afford the means of support to various products of the vegetable kind, and form the basis of soils in general; while the materials proceeding from the decomposition and decay of numerous organized animal and vegetable substances, uniting with such compounds, compose the superficial layers of rich mould, from which plants chiefly draw or derive their nourishment and support*.

* The earthy compounds usually denominated soils, are constituted or composed of a variety of very different substances or materials, such, according to the able analysis of Professor Davy, as some of the primitive earths under certain states of mixture or combination; animal and vegetable matter in the state of decomposition or decay, particular saline compounds, and the oxide of iron In common soils, the earths that are principally met with, are *silex* or the earth of flints, alumine or the pure matter of clay, lime, or calcareous earth, and magnesia.

" *Silex*, or the earth of flints, when perfectly pure, appears in the form of a white powder, which is incombustible, infusible, insoluble in water, and not acted upon by common acids; it is the substance which constitutes the principal part of rock crystal; it composes a considerable part of hard gravelly soils, of hard sandy soils, and of hard stony lands.

" *Alumine*, or pure clay, in its perfect state, is white like silex, adheres strongly to the tongue, is incombustible, insoluble in water, but soluble in acids and fixed alkaline menstrua. It abounds most in clayey soils and clayey loams; but even in the smallest particles of these soils it is usually united to silex and oxide of iron.

Soils being formed in this manner, it is evident they must vary much, both in the qualities and proportions of the ingredients of which they are composed. In one situation or district one sort of material is abundant, and consequently enters largly into the soil; in others it is deficient, while those of other kinds are plentiful, and constitute the principal parts of the soils where they are found. Some situations, too, abound much more with animal and vegetable matters than others; which produces great diversity in regard to the soils. The harder and more firm substances of nature being, on account of their structure, reduced more slowly and with greater difficulty into the state of earth, generally enter in much smaller proportions into the composition of soils than those which are of a soft and pliable disposition, and which approach nearer to the quality of earth. Thus argillaceous, loamy, and vegetable matters are found to predominate very much in soils in their primitive state, and, according to their particular qualities and proportions, to constitute very material differences in their properties. Calcareous and siliceous earthy matters are distributed over some districts in great abundance, while in others they enter into the composition of the soils in much smaller proportions, and thus contribute to vary their textures and qualities.

Soils likewise undergo much change and alteration from other matters of different kinds, being either naturally or artificially blended and incorporated with them, and from the proportions in which such mixture takes place.

There are probably few, if any, substances in nature, after they have been sufficiently acted upon, and reduced by the atmosphere and other causes, which are not capable of affording support to

" *Lime* is the substance well known in its pure state under the name of quick-lime. It always exists in soils in combination, and that principally with fixed air or carbonic acid, when it is called carbonate of lime; a substance which in the most compact form constitutes marble, and in its looser form chalk. Lime when combined with sulphuric acid (oil of vitriol) produces sulphate of lime (gypsum), and with phosphoric acid, phosphate of lime. The carbonate of lime, mixed with other substances, composes chalky soils and marles, and it is found in soft sandy soils.

" *Magnesia*, when pure, appears as white, and in a lighter powder than any of the other earths: it is soluble in acids, but not in alkaline menstrua; it is rarely found in soils; when it does exist, it is either in combination with carbonic acid, or with silex and alumine.

" *Animal decomposing matter* exists in very different states, according as the substances from which it is produced are different; it contains much carbonaceous substance, and may be principally resolved by heat into this substance, volatile alkali, inflammable aëriform products, and carbonic acid. It is principally found in lands that have been lately manured.

" *Vegetable decomposing matter* is likewise very various in kinds. It contains usually more carbonaceous substance than animal matter, and differs from it in the results of its decomposition principally in not producing volatile alkali; it forms a great proportion of all peats; it abounds in rich mould, and is found in larger or smaller quantities in all lands.

" *The saline compounds* found in soils are very few, and in quantities so small that they are rarely to be discovered. They are principally muriate of soda (common salt), sulphate of magnesia (Epsom salt), and muriate and sulphate of potash, nitrate of lime, and the mild alkalies."

some sort of vegetable or other; though there is considerable difference in this respect among different earthy matters, some being able to sustain a great number of different plants in a vigorous state of growth, almost immediately after they become mixed with the soil, while others require to be applied and united for a great length of time before they afford sustenance to any kind of vegetable whatever, and even then only yield a scanty supply of nourishment, and that for the support of a few particular sorts of plants. Where the former sorts of materials are abundant, the soils are generally fertile and productive; but where the latter prevail, they are mostly steril, and unfriendly to vegetation.

Soils are affected by other causes: besides possessing the proper earthy matters, they must be imbued with other principles, such as the aqueous and carbonaceous, and have such a consistence and texture as will properly support the plants, as well as such proportions of the several materials as will admit of their being retained, and applied in such quantities as are suitable for the purposes of vegetation according to the differences of climate in respect to moisture, and the varieties of situation in regard to the lands, in order to be rich, fruitful, and productive.

The substances, so far as they are yet known, that have a tendency to lessen the fertility of soils, are the oxides or calces of particular metals*, some coaly and pyritical matters, acids, and certain heathy vegetable substances. But some of these substances, though unfriendly to the growth of vegetables when in these circumstances, on being blended and united with other materials that enter into the composition of soils, operate upon them in such a manner as to render them more fertile than they would have been without them. Mixtures and impregnations of this nature are constantly taking place in soils, which cannot be easily comprehended or ascertained, but which produce great and important effects and changes in them. From this cause, soils, which are apparently similar in every respect, on being brought into cultivation, frequently turn out to be essentially different. Hence, too, originate many of those facts and conclusions that appear so opposite and contradictory in the science of agriculture; it is on these principles, likewise, that soils are capable of producing certain kinds of plants in great abundance and perfection, while others cannot by any means be raised upon them. It is well known to most persons conversant with practical agriculture, that soils in which calcareous matter is predominant, even when they are grown so poor and exhausted as to be almost incapable of producing any of the other crops commonly cultivated on them, will bear large and repeated crops of one sort of vegetable, that of saintfoin; and that other soils which are capable of affording the common crops in an abundant manner, cannot be made to produce this. In the same way, such calcareous soils as have been cultivated for a great length of time, and are consequently much impregnated with manure, afford

* Some late experiments by Doctor George Pearson seem to show that the *oxide* of iron is beneficial to the growth of vegetables.

plentiful crops of barley; while oat crops, if attempted to be raised upon them in such a situation, are weak, puny, and relatively extremely small. And, on the contrary, some primitive soils, not originally containing any calcareous materials, and which not having been cultivated cannot be impregnated with manures on first being broken up, often yield astonishing crops of oats, while barley can scarcely be raised at all upon them. There are many facts of a similar nature scattered through the writings on husbandry; but these are sufficient to show the great influence that very slight impregnations of different matters have in varying the properties of soils, and in rendering them more suitable for the production of one sort of crop than another, while no perceptible external differences are exhibited, by which the ablest agriculturist can be led to decide with certainty respecting their qualities.

In addition to these causes of diversity in soils, there are others that arise from their variations in respect to depth, and the quality of the subsoils on which they are placed. It is a fact well known by practical farmers, and which the experience of every day confirms, that even the soils that are constituted of the most suitable substances for the purposes of vegetation, when only a few inches in depth, and deposited upon beds of cold wet clay, rock, or chalk, are by no means so fruitful and productive as those which are thicker, though of inferior quality, but resting on a bottom which is more dry and gravelly. The difference of weight and tenacity in the under strata of soils, likewise introduces great variety in regard to their powers and capabilities of rearing vegetable productions.

It has been shown by the analysis of Mr. Davy, that the fertility and barrenness of soils must necessarily be different in different climates and under different circumstances; and that the capability or power of their absorbing moisture, which is a property essential to their productiveness, should be much greater in warm and dry countries than in those of the cold and moist descriptions, as well as the proportion of fine aluminous earth larger. On the sides of hills, or declivities, the soils should likewise be more of an absorbent nature than in the low lands or valleys, even in the same climate. The nature of the sub-strata, as has been observed, has also much effect on their fertility, and should be well considered in the practice of improving them; as a sandy soil may in some instances owe its fertility to the capability of the under strata retaining water; and an absorbent clayey soil, in particular cases, be prevented from being unproductive in a humid soil by the influence of a sandy or gravelly sub-soil.

It has likewise been demonstrated, that such corn soils as are the most productive invariably contain certain proportions of aluminous and calcareous earths in a very minute state of division, as well as a certain quantity of vegetable or animal matter; but that in some cases the proportion of calcareous earth is extremely small. In a very fertile soil of this sort from East Lothian, on analysis, only eleven parts out of one hundred of mild calcareous earth were afforded; there being twenty-five parts of siliceous sand, and forty-five of finely divided clay, with a loss of nine, in decomposed vegetable

and animal matter, and four in water, a small portion of phosphate of lime being indicated. This soil was of a very *fine* texture, and contained few stones or vegetable fibres. It is suggested as not improbable, that the fertility of it in some measure resulted from the phosphate; as this substance is met with in wheat, oats, and barley, and may be a part of their food or nourishment.

Another soil from the low lands of Somersetshire, highly productive in wheat and beans without manure, was found to consist of one-ninth of sand chiefly siliceous, and eight-ninths of calcareous marle tinged with iron; with about five parts in the hundred of vegetable matter. And as neither phosphate nor sulphate of lime could be discovered, it is conceived that its fertility must have depended in a great degree upon the power or capability of drawing the principles of vegetable nutrition from water and the surrounding atmosphere. A soil constituted of three-eighths of clay, two-eights of river sand, and three-eighths of the parings of limestone, was found proper for wheat in Mr. Tillet's experiments.

After having remarked, that for bulbous-rooted plants and trees the soil should be more sandy and less absorbent than for those of the grass kind, it is stated that a very good potatoe soil from Cornwall afforded, on being analysed, seven-eighths of siliceous sand, the absorbent power of it being so small, that one hundred parts lost only two by drying at four hundred degrees of Fahrenheit.

Such plants and trees as have hard fibrous roots capable of penetrating deep into the ground, are said to grow to advantage in most sorts of common soils that are moderately dry, and which do not contain a great excess of vegetable matter. In a soil, taken from a field in Sussex, which produced very fine oaks, there were found to be six parts of sand and one of clay and finely divided matter. And one hundred parts of the entire soil on analysis afforded of: water 3 parts, silex 54, alumine 28, carbonate of lime 3, oxide of iron 5, decomposing vegetable matter 4, loss 3.

With regard to the improvement of soils, where they are of the barren kinds, they should, on examination, be compared with those of the highly fertile descriptions in similar situations and neighbourhoods; as by this means it is supposed the differences afforded in such trials would lead to the proper methods of cultivation, and the plan of improvement be thus founded on just principles. Where the fertile soil, for instance, was found to contain a large proportion of sand in comparison to that of the barren kind, the process of amelioration would depend upon a supply of this material. And the same thing would be the case, in respect to the deficiency of clay or calcareous matter. It is suggested that in the application of clay, sand, loam, marle, or calk, to ground, no particular chemical principles are to be regarded; but when lime is made use of, care should be taken that it be not provided from magnesian limestone, as that sort has been found injurious to land by Mr. Tennant. Where the analytical comparison shows an excess of vegetable matter to be the source of barrenness, it may be diminished or destroyed in different ways, as by much pulverization and exposure to the influence of the atmosphere, by paring and burning, and the action of lime in its most caustic state. The de-

ficiency of animal and vegetable matter may be supplied by the use of manures of these kinds according to the circumstances of the cases.

The test of chemical examination will be particularly beneficial in showing the deficiencies in the proportions of the primitive earthy materials; as merely a temporary food is provided, by the application of animal or vegetable manure for plants, which is invariably exhausted by the growth of a certain number of crops: but when a soil is rendered of the best possible constitution and texture, in regard to its earthy parts, its fertility may be considered as being established in a lasting manner;—it is in a condition to draw large supplies of vegetable nourishment from the atmosphere, and capable of affording crops, with comparatively trifling labour and expense.

In a subject where there is such a great diversity, originating from such minute circumstances and almost imperceptible causes, as is the case in respect to the nature of soils, it is extremely difficult to point out any rules or marks by which they may invariably be ascertained. Several methods have been proposed by agricultural writers for the accomplishment of this highly necessary and important point. The mode by chemical analysis is unquestionably the most certain and exact; but it requires, for the most part, more knowledge and dexterity than is commonly possessed by the mere practical farmer, and in many cases is tedious and expensive. It can, therefore, be only well executed by those who are conversant with the science of chemistry, and to whom expense is no material object. The natural appearance of a soil may, in certain instances, afford the means of ascertaining its quality; but as few persons are sufficiently acquainted with the vast varieties of soils which occur in nature, it is a method that must obviously be extremely uncertain and confined, and which on many accounts is open to great objection.

There is another means of deciding in respect to soils, which, in many cases, when properly limited, and exercised by a person of sound judgment and duly experienced, is certainly not a bad one, though in some respects also defective: it is that of determining from the nature of the plants that are produced, and the degrees of their growth and luxuriance. Thus, where plants that are only accustomed to grow in good or peculiar sorts of soil are met with in their natural and flourishing states in other places, the soils may be concluded to be of this or that kind, according to the circumstances in which they are found. In this way the common nettle and the rush may characterize different descriptions of soil; the former being found to grow the most luxuriantly on the dry loamy soils, while the latter delights in the wet cold clayey ones. The growth of certain sorts of timber trees and hedges may also, in various instances, serve to direct the judgment; and likewise the appearances or colours of the mould in particular instances: thus, hazel-brown denotes a good sort of loamy soil; and reddish sandy earth, a favourable one of the lighter kind. Too few observations have, however, yet been recorded by practical writers, concerning the distinctions afforded by the growth of different plants on different soils, to render it a method of extensive utility and application. Until further at-

tempts be made, therefore, in this or some other way, and a more full and ample collection of facts be brought forward, the safest and most advantageous plan will, probably, be to rest upon the basis of experience, by which, from the combination of various little circumstances, the agriculturist may, in most cases, be led to a safe decision. Several circumstances which may serve as guides in this difficult business, will be noticed in considering the nature of hiring and stocking farms.

The soils of this country have been described under numerous heads, and distinguished by an useless variety of vague local terms. They seem, however, to be capable of being considered and characterized, as far at least as is necessary for practical purposes, under the distinctions of

Clayey,	*Chalky,*	*Peaty or Mossy,* and
Loamy,	*Sandy, Gravelly,*	*Vegetable Earthy soils.*

Each of these divisions must of course comprehend several varieties, according to the nature and preponderancy of the different sorts of materials of which they are constituted or composed.

Clayey Soils.—Soils of this kind differ very materially, according to the nature and quantity of the clay that enters into their composition, and the adulteration which has been produced in it by the intermixture of different earthy matters, as well as various mineral, vegetable, and animal substances. For clays are in general far from being pure in the states in which they are found in the earth. They are in many instances united with large proportions of siliceous or sandy matter. On these accounts it is that the clayey soils of some districts are so abundantly fruitful and productive, while those of others are insuperably sterile and refractory. Farmers, or those engaged in cultivating land, for the most part being only acquainted or conversant with earth or mould as it offers itself to their attention in the gross or whole, have not been led to remark the astonishing diversity that takes place in respect to the properties of clays, and other bodies that are united with them, as primitive and constituent parts of soils, in their original and native states; but, having found that they all agreed in possessing the property of imbibing and retaining moisture, and thereby becoming soft and ductile, have, probably too hastily, concluded them to have, in some measure, a similarity in their other qualities. In this way erroneous notions have frequently been engendered respecting soils in which these substances abound. For it is well ascertained from the use of clays in states of greater purity, that there are very essential differences in their qualities. There are some sorts, as that which is denominated fullers-earth, and several of the softer boles, that have the cohesive property in but a very slight degree; while others, such as those which are termed *tills*, are so extremely tenacious and viscid as to be capaple of being drawn out into threads. And there are still others which, from their softness, and property of imbibing water readily, are capable of being cut with any sharp instrument; while some other sorts are so firm, hard, and compact, as scarcely to admit of being softened by means of water. The clays which

are employed for making the finest porcelain, and those used in the composition of the more coarse wares, are only to be met with in particular situations and districts.

These facts not only show that there is a prodigious variety in respect to the qualities of these substances, but that they must afford equal variety to the soils into which they enter, and therefore require to be more closely examined and more nicely ascertained than they appear yet to have been, before *all* the varieties of soil usually classed under the denomination of clayey can be well ascertained and understood.

But these substances do not differ only in their properties and qualities, but likewise in their colours, and the closeness with which their particles are united. They are found in their natural states of various colours; such as red, white, blue, and yellow; and of different degrees of density, so as, in some instances, to readily admit of being united with the different materials that are applied, in order to ameliorate their conditions; in others they can scarcely be made to join with them by any means in the power of the agriculturist. In soils of the first kind, the quantity of siliceous or sandy matter, in general, bears a much larger proportion to that of the argillaceous or clayey, than in those of the latter, and in many cases too the mixture of other substances is proportionably larger. The nature of the clayey stratum, in respect to its thickness or thinness, as well as its contiguity or remoteness from springs of water underneath it, is too commonly over-looked in considering these sorts of soils; but all these circumstances demand particular attention, and ought to have considerable influence in directing the means of cultivating and improving clayey soils.

It is obvious, from what has been already advanced, that, notwithstanding the differences that take place from the accidental mixture of different materials, in different degrees and proportions, all the descriptions of this sort of soils must possess more or less of the heavy and adhesive stiff qualities; and that according as these are more or less predominant, due respect being at the same time had to the various other circumstances that have been stated, the business of cultivation and improvement must be varied and applied. In general they will require greater strength, and more labour and exertion, to bring them to that state of pulverization and fineness which is the most suitable for the various intentions of husbandry, than may be requisite in many other kinds of soils. Besides this, as they are frequently defective in the proper ingredients for the support of vegetation, and faulty in their texture, as well as combined with principles which are necessary to be corrected, the applications of ameliorating substances should constantly be conducted with these as well as other views. Chemical analysis has now shown in the most full and satisfactory manner, and the fact has been confirmed by the general experience of practical farmers, that substances of the calcareous kind are the most advantageous in improving and bettering the condition of all clayey soils. Where the deficiency is in the texture, and want of the calcareous ingredient, limestone, gravel, and calcareous marles are the most useful and proper.

If, however, these substances cannot be procured, a mixture of the coarser kinds of sand with perfectly effete or extinguished lime may be employed; and even chalk, sand, or lime-stone, in the state of coarse powder. Coal ashes, clay which has undergone the heat of the fire, and small pebbly gravel, are also sometimes useful. Lime alone may frequently be made use of with great and permanent benefit; though it is thought by some that it is less proper, from its tendency to cake, and its not opening and uniting sufficiently with the soils.

But where, as well as these, there is likewise a want of vegetable matter, mixtures of calcareous marle or lime, and farm-yard dung, and such composts as are formed by combining lime or chalk with light sandy or gravelly earths; or lime and chalk incorporated with sea weeds and sea-sand, where they can be sufficiently procured; would likewise be highly useful applications in these circumstances. Peat-ashes are, in some places, used with success; and gypsum, when mixed in a small proportion with any of these vegetable products, would, probably, be found highly efficacious in this condition of clayey soils, where they are tolerably dry. This substance, as well as lime and chalk, may also be beneficially employed on soils of this nature that abound with acidity, in order to neutralize, and thereby correct the injurious properties of such principles.

Most of these modes of improving clayey soils are practised with success in one part or other of the kingdom. In Scotland, where lime is probably more employed on clayey soils, especially those of the better cultivated sorts, than in England, they commonly apply dung the same season that the ground is limed, but not in combination with it: by this method the lime is supposed to operate more powerfully, and with much greater expedition, than when used in the way of compost. Chemistry has sufficiently demonstrated, that lime in its active state has great effect in promoting the solution of vegetable substances, and consequently of greatly augmenting the quantity of that kind of matter in soils. In this manner the quickness of its effects may be easily accounted for, where, in such cases as that just stated, a large mass of vegetable materials is immediately placed in contact with it. It appears, however, probable, that where these matters are employed in this way, the beneficial effects expected from them will not be so permanent or durable.

These means of improving the condition of different sorts of clayey soils may be greatly augmented and assisted by a judicious and well-conducted system of tillage. The ploughings and harrowings on these soils, especially where they are very tenacious and stubborn, should be more frequently repeated, and at such seasons of the year as they are not too dry and cloddy, or too wet and pouchy, in order that they may be well broken down, and sufficiently exposed to the operation of the atmosphere, and thus acquire a considerable degree of fineness, by which the growth of plants is much promoted. When the seed is put in, the harrowing should be performed in such a manner as to cover it very perfectly. The depth of ploughing on such soils must be regulated by the circumstances of the case, and the particular situation of the ground. Where they

are thin and have a gravelly subsoil, and are liable to be injured by their proximity to springs of water, it should not be so deep as where they have a better staple, and are less in danger from water below them.

As most of the soils of this class, from the nature of their constituent principles, must be more retentive of moisture than those of several other kinds, it is highly necessary, especially in the winter season, that every method be taken to keep them as dry as possible. This is not less requisite in respect to the lands that are in the state of pasture than those that are under an arable system of husdandry, as the stagnation of much water is equally injurious whether the crops be corn, roots, or grass. Besides, where such soils are in a state of aration, by proper attention to such means, they may at a more early period in the spring be in a better and more fit condition for the plough, and the reception of the seed; by which the danger of the crop, of whatever kind it may be, being inconvenienced by too much wet or dry weather, will in a great degree be avoided; as, when this sort of soil has once been well broken down and reduced by the different operations of harrowing and rolling, and the seed put in, it seldom sustains any injury from the dryness of the season afterwards

In the tillage of soils of this description, from their stiff nature, it will likewise always be necessary to have the implements that are made use of of more strength than in other cases, and to have the animals that are employed in drawing them so attached as that they may do as little injury as possible by their treading. On this account, in ploughing such lands it may be most advisable to have recourse to such kinds of ploughs as admit of the horses drawing singly, and following each other in the bottom of the furrows *.

In the fallowing of clayey soils, it is also necessary for the farmer to attend to the particular state of the season, and not break up or stir them when they are very dry or very moist, as in either case he must obviously perform the business to great disadvantage; but to choose as near as possible, proper regard being had to the nature of the crop that is to be put in, such times as that the ground is neither too dry nor hard, so as to be stirred with great labour and difficulty, nor too much impregnated with moisture, so as to render it very adhesive and poachy.

In ascertaining the nature and goodness of clayey soils, much assistance may frequently be derived from an attention to the aspect of the different sorts of trees, and the appearances of the various crops; as where particular kinds of trees, such as the oak and elm, and hedge plants of various kinds, are in a state of luxuriant growth, and where grain and other vegetable crops, as well as the grass lands, are in a healthy, vigorous, and flourishing condition, favourable conclusions may be made; but where the former have a stunted unhealthy appearance, and do not grow with vigour, and the latter are thin and short, they may be decided to be poor, and unfriendly for the purposes of vegetation.

* The swing-plough answers very well for this purpose.

Loamy Soils.—Soils of this description, as characterized by agricultural writers, are probably much too numerous; yet, from their being compounded of very different sorts of materials, they undoubtedly admit of considerable variety. The substances that are most commonly found to contribute to the formation of loamy soils, are clay, sand, gravel, and chalk. Sometimes an oxide or calx of iron is also found blended with them in a small proportion. In proportion as the argillaceous or clayey principle diminishes, they recede from the nature of the clayey soils; consequently the nearer the quantity of that substance approaches to that of the other, the stronger and more heavy will the loamy soil be. The differences in the lightness and friability of the soils of this class in a great measure depend on the relative proportions of the other ingredients. Where the calcareous ingredient greatly exceeds those of the sandy or gravelly kinds, they are neither so light nor so pulverizable as where they are nearly equal, or where the sandy or gravelly matters considerably predominate over it. In the latter case, indeed, such soils are formed as have been denominated by practical farmers *light and hungry*, especially where the earthy bed or stratum thus produced is but of little depth, and rests on a gravelly or flinty bottom or subsoil.

The variety in the colours of soils of the loamy kind seems in some instances, to be produced by the union or mixture of metallic substances in greater or less proportions, and in more close or more lax states of combination with them; in others, by the prevalence of acid impregnations. The colour in the first case is for the most part reddish, approaching to brown; in the latter it is commonly blueish, changing by heat to a slight red. But these are not the only causes that influence the colour of these soils; they are much altered in their appearances, as well as other qualities, by the different proportions of vegetable or animal matter which they contain, and the different states of decomposition and decay to which they have been carried by length of time, cultivation, and other means.

In situations where this sort of soil has been but little disturbed, and consequently little changed by the artificial additions of either animal or vegetable substances, and those which it naturally contained not having advanced to the stage of perfect solution and decay, it is generally found of a light brown or hazel colour; but where much culture has been employed for a length of time, and large applications of animal and vegetable matters frequently made, the natural and artificial materials of these kinds having proceeded more nearly to the state of perfect resolution aud destruction, it has an appearance that approaches to that of black. From these various circumstances the properties of the soils are likewise considerably altered and affected, as well as their colours changed.

This sort of soil being less close, compact, and adhesive, than the clayey, admits much more readily of amelioration and improvement. Respecting the more stiff and heavy kinds, in which the argillaceous and calcareous principles are the most abundant, and where the carbonaceous or vegetable principle is frequently deficient, the most appropriate and suitable means of rendering them fertile and productive would seem to be the application of lime, in the way of com-

post or combination with different vegetable and animal materials, such as farm yard dung, blood, ground bones, and similar matters, and such earthy substances as contain large proportions of sand and gravel in different degrees of tenuity or fineness. The quantities in which they are to be applied must be determined by the particular circumstances and the situation or state of the grounds. In general, however, these soils do not stand in need of so much of any sort of manure as those of the clayey kinds. Lime may sometimes be used alone; as where the land abounds with vegetable matters, and the calcareous principle is in too small proportion, and where there is a prevalency of acidity or sourness in the soil, which is not unfrequently the case where it approaches the nature of clay. But in those soils of this nature in which the calcareous and sandy or gravelly ingredients enter in sufficient proportions, good rotten dung, the vegetable matter produced from the decay of plants, and obtained by deposition from stagnant water in ponds and other places, with several similar substances, may be used with the most success; and where those bodies are too predominant, or in an over-proportion, so as to render the soils over light a portion of clayey loam may be united with such substances with great advantage.

The loamy soils which are met with in extensive districts on the banks or borders of the sea, and of large rivers communicating with it, are generally so well constituted, and so fertile, as to demand little improvement from manures. The principles which mostly abound in them are a fine sort of sand, calcareous matter in a higher state of tenuity from the attrition or rubbing down of different kinds of shells and other marine productions, and a rich matter proceeding from the dissolution of various luxuriant sea-plants, and innumerable sorts of animal exuviæ. These alluvial materials are all gradually deposited and incorporated with the natural loamy earth of the regions or places in which they are found, and thus constitute soils of the most fertile and productive kinds.

From the soils of the loamy class being more friable and brittle, as well as more dry, than most of the clayey ones, they are capable of being tilled with much greater ease and facility, as well as much less strength of team, and at almost every season of the year: and, on account of their property of receiving and transmitting moisture more freely, they are less apt to be indurated by too much too dry, or chilled by too much wet weather. Besides they are more influenced on exposure to the agency of the atmosphere and other external causes, and thereby more adapted for the promotion and support of vegetation. And as they are found in most cases to be less disposed to the production of weeds, particularly those of the more injurious kinds, they can of course be kept clean with much less labour, and without the expensive system of management which is requisite on many other kinds of soil.

Chalky Soils.—Soils of the chalky or calcareous kind occupy very extensive tracts of land in different parts of the kingdom, and are marked with considerable diversity, as proceeding from the nature, properties, and proportions of calcareous matter as it exists in them; the substances that are mixed and combined with it; the depth and qualities of the earthy stratum which is placed upon it;

and the disposition of the sub-soil or basis on which this is formed and deposited.

Calcareous matter is contained in many different stony substances, besides that of chalk; as marble, lime-stone, coral, and shells of different kinds; and in states of union with other materials, such as sand, the different simple earthy bodies, in different proportions, and in some instances with iron and magnesia. Its capability or powers of imbibing and retaining moisture is considerable, though not so great as that of clay. It burns to lime by proper degrees of heat, and absorbs carbonic acid gas or fixed air in different proportions from the atmosphere, and returns again to the state of chalk or effete calcareous matter. It is found of very different degrees of hardness and friability, as well as of different states of fineness or pulverization, in different soils of the class to which it belongs. It varies also greatly in its effects in respect to vegetation; from the different matters that may happen to be combined with it in its primitive or original state. It has long been known to the practical agriculturist that some sorts of lime may be employed in large proportions; while others cannot be used, except in very small quantities without doing very considerable injury to the soil with which they are incorporated. The long unexplored cause of this diversity of effect in different limes seems lately to have been placed in a more clear and satisfactory point of view, by the experimental attempts of an ingenious philosopher *. He has found by repeated experiments, that that sort of lime which is the most friendly to vegetation, consists entirely of calcareous earth, and quickly absorbs a large portion of carbonic acid gas, or fixed air, from the atmosphere; while that which is injurious and unfriendly to the growth of plants contains only three parts of pure calcareous earth, the other two consisting of magnesia, and that it absorbs comparatively but an extremely small portion of carbonic acid gas, or fixed air, from the surrounding atmosphere. This kind or mixture of calcareous matter was also ascertained to be very slow in acquiring the power of supporting vegetation, even after it had been converted into lime, and remained for a considerable length of time in the state of mortar. The lime-stone, in which there is a mixture of magnesia is much harder, and dissolves considerably more slowly in acids than that which is purely calcareous. The same author likewise supposes that the crystallized structure commonly observed in the magnesian lime-stone, indicates that it has not been formed by the accidental conjunction of the two earths, but constituted by their chemical union. The difficulty with which it is dissolved by means of acids may also, he thinks, in some measure depend on the attraction of its different component particles to each other.

This sort of lime-stone would seem to abound in different parts of the kingdom. It is observed to extend for thirty or forty miles from a little to the southwest of Worksop, in the county of Nottingham, nearly to Ferry-bridge in Yorkshire. In the account of the agriculture of the midland counties, Mr. Marshall observes that the lime made at Bredon, in Derbyshire, is hurtful to vegetation when

* Tennant on the different sorts of lime used in agriculture, in Transactions of the Royal Society, 1799, Part ii.

employed in large proportions; and our experimenter has found that it contains magnesia nearly in the quantity stated above; but that the stone in this instance is frequently crystallized in a rhomboidal form; and petrified shells, not calcareous, but similar to the composition of the stone itself, are occasionally, though seldom, found in it. The different combinations of calcareous matters are sometimes found contiguous to each other. At Matlock, in Derbyshire, it is stated that the rocks on the side of the river where the houses are built are magnesian, while those on the other are calcareous; and that the magnesian rock appears to be incumbent on the calcareous stratum; as in descending a cave formed in this rock, a distinct vein of common lime-stone may be seen which contains no magnesia. The calcareous stratum is very full of shells, and there are also some in the magnesian rock, but they are extremely rare. The practical distinctions of hot and mild limes, which have frequently been made by those engaged in the improvement of soils, and which have been particularly attended to by a late writer, prove that the magnesian calcareous matter is met with in the more northern counties; that which is considered as hot being also found by him to be more difficult of solution in acids. These important and interesting facts not only show, whatever sameness there may be in the nature of calcareous matter when in its pure and unadulterated state, that as met with in soils, and different substances of the calcareous kinds, it has considerable diversity, and when in union with magnesia it is in a high degree prejudicial to the growth of vegetables.

Calcareous matter, whether it be in the effete or state of *carbonate*, or in the more active one of causticity, as quick-lime, seems ultimately to promote the resolution and destruction of vegetable and animal substances: in the latter state, however, it acts with much greater violence on these materials, destroying their organization and dissipating their principles more quickly, as well as robbing them more completely of the carbonic acid gas, or fixed air, which is so essential; while in the former it operates with great mildness, and only aids the resolution of those substances by gently promoting the process of putrefaction.

The proportions of clayey, loamy, and gravelly ingredients, which are conjoined with the calcareous matters of these soils, are various in different districts: where the argillaceous and loamy materials are comparatively in large quantities, soils of the heavier chalky kinds are formed; and where the sandy or gravelly are predominant, we have the lighter ones. There are also material differences proceeding from the earthy matter with which the calcareous ingredient is mixed in the state of soil. Where the quantity of this is small, and not reduced into any very perfect state of mould, the soil, as is evident, must be poor and thin; but where the depth of this superficial stratum is considerable, and the animal, vegetable, and other substances, of which it is composed, are advanced to a more complete stage of decomposition and decay, the soils are more rich and heavy. Some variety is likewise caused by the state of the under-stratum, or sub-soil. If it be compact, and much intermixed with siliceous or flinty matter, or have a mortary hardness, it is less favourable than where it is of a more open, brittle, or powdery texture.

From what has been stated, the means of improving chalky or calcareous soils must be evident. As the calcareous principle is here abundant, the principle intention is the alteration of their textures, and the supplying of vegetable matter. This is effected, in the heavier sorts of chalky soils, by the application of clayey and sandy loams, according to the particular circumstances of the cases; and in the thinner or more light lime-stone soils, it may be accomplished by means of clay, argillaceous marle, and the rich imperfectly decomposed vegetable matter arising from the deposition and accumulation of such substances in low, close, and wet situations.

Farm-yard dung, and composts of all kinds of dung, with good mould, will be advantageous. Soot and malt-dust have, likewise, in different instances, been successfully employed.

Where mischief has been experienced from the too great abundance and prevalence of magnesian lime, or calcareous matter, the plentiful use of ashes produced from the combustion of fresh vegetable substances would seem to be the most suitable application as a remedy.

Whatever appearances of lightness there may be in chalky soils, they require considerable strength in the team, where the staple or earthy stratum of the lands will admit of their being wrought to a tolerable depth; but where there is a thinner surface of earthy materials, less force of draught will be requisite. In the latter cases, the soil is, however, far more precarious and uncertain, as well as much less productive in respect to the crops that are cultivated upon it, than in the former. As chalky soils are not so liable to be injured by water as others, the business of tillage is much less impeded from that cause; but a dry season sometimes renders them so hard as to be totally incapable of being broken up, until they have been moistened by the falling of a considerable quantity of rain. From the great wear, by friction and other causes, that takes place in the ploughing and breaking-up of most soils of this class, the state of the irons of the ploughs or such other instruments as are employed must be more frequently and more particularly attended to, as from the neglect of this circumstance much inconvenience, as well as loss, may arise to the farmer.

Sandy Soils.—Sands seem to have been gradually formed by the attrition and rubbing down of the various solid substances that are found in nature, especially such as are of the siliceous, calcareous, and stony kinds, and are of different degrees of fineness as they approach the size of gravel. They are also met with of various colours and appearances in different regions or tracts of country; such as white, dusky brown, yellow, and red. These differences, as well as those which respect their weight, tenacity, and other properties, depend on the nature and proportions in which many other sorts of materials enter into combination with them.

Where the proportions of clayey, loamy, or other earthy substances with which they are mixed approach nearly to that of the sand, the heavier sorts of sandy soils are formed; but where these enter only in very small quantities, we have the light sandy soils; and where they are hardly met with at all, the soil is a loose blowing sand,

most commonly of a white or brownish appearance. The portions of vegetable matters that are intermixed with different soils of the sandy kind are not less various than those of the clayey and loamy, from which considerable differences of quality are produced. These differences in their textures and compositions also introduce others which respect their powers of admitting and retaining heat and moisture. The openness and want of adherence in such soils, while they allow of the admission of heat and water more readily, permit them to be carried off with greater ease and expedition; they are therefore less permanently benefited by their influence than many of the closer and more adhesive soils.

From this view of the constituent principles of sandy soils, it is obvious that they are chiefly deficient in the calcareous, argillaceous, loamy, and vegetable ingredients. The intention of the agriculturist should, therefore, for the most part be directed to the augmentation of their cohesive property, and the supply of the calcareous and decayed animal and vegetable matters. With a view to the first, argillaceous and loamy materials may be had recourse to: and it has been observed by an able and intelligent writer, that a less proportion of clay is required in the improvement of light sandy soils, than of sand in clayey ones; but whether this rule be generally correct or not, some of the thinner and poorer sorts of sandy soils certainly demand large proportions of the argillaceous ingredient. Where the calcareous principle is in sufficient abundance, argillaceous marle and clayey loams are the most suitable; but where it is deficient, calcareous marles and loams will be more advantageously employed. On these principles it is, that in the counties of Suffolk, Norfolk, York, and some districts of Scotland, experience has shown the former to be more beneficial; while in other places, as the Isle of Wight, the district of Caermarthen in Wales, in the counties of Sussex, Chester, and Stafford, in England, and the northern parts of Scotland, the latter has been found to produce the most advantageous effects on sandy soils.

The defect of vegetable matter in these soils may be remedied by the use of farm-yard and other composts, proceeding from animal and vegetable substances in a state of putrefaction, But good earth, or mould, and the imperfectly resolved matter found in boggy situations, may also in many instances, where these cannot be easily procured, supply the deficiency in a very beneficial manner.

The folding of sheep upon soils of this nature, likewise, contributes greatly to their improvement, not only by the quantity of dung and urine that is deposited upon them, but the consolidation and firmness of texture that is produced by their treading.

All these different sorts of materials may be applied either alone or combined with one another in the form or state of composts. The marles and clayey substances are, however, for the most part, laid on in the states in which they are found; but the farm-yard dung, and peaty matter often in mixture with each other, or with substances of other kinds, such as those of an earthy nature: the peaty earth may also frequently be used alone, when applied to the surface of pasture lands.

The light, open, and porous texture of sandy soils renders them much more easily cultivated and kept in order than those of the strong and close kinds: consequently the farms where they prevail are generally large; and when properly prepared they are better adapted for the growth of many sorts of crops, such as those of the bulbous and tap-rooted sorts. They have also another advantage, which is that of pushing forward the crops with more expedition. Whatever inconveniences attend them, they are mostly such as proceed from the want of a sufficient degree of cohesion among their constituent particles, and solidity of texture. On these accounts they often counteract the best and most judicious management. The roots of the crops are liable to become naked and exposed from storms and various other causes; and if grain, to fall down and be lodged so early in the season as to render them of little value.

GRAVELLY SOILS.—In the state of gravels which contribute to the formation of this class of soils. there is a variation of size in the pieces or particles of which they are composed, from that of a very small pea to the largest cockle. Where they become of still larger dimensions, they are termed stones, or rocks, according as they are in small portions or large masses; and the soils are then said to be stony or rocky, as the circumstances of the different cases may happen to be.

The beds of gravel, whether they be of the larger or smaller kinds, are mostly either of the siliceous or flinty nature, or of the calcareous or chalky; but the stones and rocks are of very different kinds. With these dissimilar substances, some others in different states of reduction and pulverization are blended and united in various proportions, so as to constitute gravelly soils that differ considerably in their textures and other properties. The chief of these are loams, and the mould or earthy matter formed by the destruction and decay of numerous animal and vegetable substances.

The gravelly mixture is sometimes also found to approach nearly to the surface, while at others it recedes considerably from it *. In some instances springs rise immediately underneath; in others they are at a great depth. The bottom, or sub-soil, is likewise various; in some cases it is stony and rocky, in others it is clayey, or a rocky gravel, and sometimes sand, &c.

The open porous nature of gravelly soils disposes them to admit moisture very readily, as well as to part with it with equal facility; from the latter of which circumstances they are subject to burn, as it is termed, in dry seasons; which is not the case in the heavier or more retentive sort of soils.

The defects in the constitution of gravelly soils may be removed by the applications of one or other sorts of marle, where they can be procured, according to the circumstances of the case. Where the gravel is of the calcareous kind, clay or clayey loam may be most properly

* It is observed by Mr. Middleton, in his excellent Report of the Agriculture of the county of Middlesex, that "when the gravel is very near to the top, a full crop of yellow-blossomed broom covers the ground if in a state of grass, and when ploughed an equally full crop of sorrel." This he remarked in the old inclosures, and on several places on Enfield Chase.

made use of. And a mixture of the carbonate of lime, or lime in its effete state and clay, would seem to admit of a pretty general application to these soils. Chalk, as being of the same nature, may also be made use of in the same way. Indeed, for these kinds of gravel, which from their contiguity to springs are apt to lie wet in the winter, there is no manure more properly adapted than chalk; which, although it does not abound with vegetable matters in any large proportion, like yard-dung and some other dressings, is, however, an excellent preparative for them, and will, in some measure, supply the place of such substances. From its absorbent nature, it is of good effect not only to counteract the superabundant moisture of such soils, but to lessen their heat; by which means the disposition to burn in the summer, so inimical to the growth of various crops, and to which all gravels are in some degree liable, is prevented; and in this last view, chalk, though particularly adapted to those of the wet and springy kind, may be applied with success on gravels of almost every denomination.

The deficiency of the vegetable and animal earthy matters, where it exists, may be properly supplied by dung of the farm-yard kind in its more rotten state, and various animal excrements. These are frequently applied to the gravelly soils, with the greatest effect and advantage, in the form of composts, with good loamy mould, ashes, the mucilaginous and clayey depositions of rivers and ponds, and other substances of a similar kind. Several of these materials, and some others of the animal class, are, however, often used separately to the surface of soils of this sort.

Soils of this description may also be much improved by a judicious variation of the green vegetable and other crops that are cultivated upon them.

Gravelly soils, from the lightness of their texture, and their not affording great resistance, except where the stones are large, or there are rocks, are not expensive or difficult in the means of cultivation. All the necessary business of this sort is capable of being carried forward with much ease and expedition; and the lands are, in general, soon brought into the proper states for the reception of crops.

Peaty or Mossy Soils.—These soils are met with in pretty extensive tracts in many parts of the kingdom. In some places in England they are provincially denominated moory, peaty, and heathy soils; in Scotland they are more commonly known by the title of mossy; and in Ireland they receive the name of boggy soils. They differ, like all the other kinds of soils, from the nature of the ingredients of which they are constituted or composed, and the proportions in which these are found to prevail in them. Where the vegetable or peaty material predominates but little over the other substances with which it is mixed and incorporated, the lighter sorts of peaty, moory, or heathy soils are formed; but where the other matters bear only a slight proportion to it, the deep and heavy, peaty or mossy soils present themselves. In different districts the peaty matter is found of different depths, and of various degrees of density or closeness of texture, probably proceeding from some original differences in the vegetable substances from which it was formed, or the

greater advances which it has made to the state of perfect decomposition or decay. The sub-soil in most of the deep mossy districts is of the clayey kind, more or less stiff and heavy, over which the peaty or mossy material is deposited, generally in a sort of stratified order; the first layer of which, being commonly not more than ten or twelve inches in thickness, exhibits the appearance of a richish brown earth, in all probability from the incorporation of the loamy or clayey matters with the peat or vegetable earth laying immediately upon them, and constituting originally, perhaps, the surface of the ground. The layer that succeeds to this is mostly of a dark colour, and considerable thickness, apparently formed of a great variety of vegetable or other materials in the more perfect stages of resolution and decay, united together by time and other circumstances with more or less compactness and solidity. The uppermost stratum, or that which is placed upon this dense, peaty matter, is in general of a very pale colour, and very light spongy texture, arising possibly from the grasses, leaves, and other vegetable substances, of which it is formed, not having attained that state of decay which constitutes the darker sorts of peaty earth.

But in the more superficial peaty soils, little or nothing of this stratified appearance is met with. A coat of peaty earth, differing greatly in thickness according to the peculiarity of the situations, and other circumstances, is formed by a great length of time from the destruction and decay of successive crops of grasses, leaves, and substances of the heathy or other kinds, and deposited upon, and intermixed with, the various harder materials of the soils which happened to be underneath them. By these means much variety is produced in the soils. Where the under strata of earthy matter are tolerably good, and the crops of vegetables large and luxuriant, the better sorts of light peaty soils seem to be predominant; but where the quality of the under strata is indifferent, and the vegetable products scanty, as well as feeble in their growth, and principally of the heathy tribe, the poor peaty and heathy, or moory soils, are met with.

All peaty soils seem to be thus gradually formed by the deposition of vegetable matter, supplied by the dissolution and decay of aquatic and other plants that grow in low moist situations, as well as substances of other kinds brought down by water, from the high grounds in their neighbourhood, in the states of solution and diffusion, and gradually deposited from it on its becoming in a state of stagnation, by means of obstructions and stoppages proceeding from different causes.

From the nature of the composition of these soils, it is obvious that they must be very retentive of water, especially where they are of any great depth: hence they seldom or ever become free from the excessive quantities of moisture with which they are loaded in the rainy seasons. An able author justly observes, that from the rays of the sun and drying wind being exerted during the summer season in carrying off, by means of evaporation, the superabundant moisture in such cases; and heat being known to be abstracted from bodies, and cold generated thereby, effects must be produced highly injurious not only to climate but vegetation in general, and more particu-

larly to such plants as stand in need of a higher degree of heat and more nourishment than such soils are capable of supplying.

And he thinks that there can be very little doubt but that these prejudical effects on the growth of vegetables extend themselves to the more dry lands adjoining such fens or deep mosses.

The surface stratum of peaty soils, from its being more exposed to the influence and action of the pure air of the atmosphere, is, it is also observed, much less soluble than the under strata, consequently in its simple or unmixed state less proper for the purposes of agriculture. From the same cause, too, it becomes less capable of supporting flame, and is therefore improper for the purposes of fuel.

From what has been observed respecting the composition, formation, and properties, of peaty soils, it is evident that they must require different methods of management, in order to reclaim and render them suitable for the growth of the various sorts of vegetables that are objects of husbandry.

In the deep mosses, the first thing to be attempted is to draw off, as much as possible, the superabundant moisture, by the cutting of proper drains, and such other means as the nature of the situation and other circumstances will admit of. In places where water in sufficient quantity can be conveniently made to pass through such mosses, and where the soil underneath is good, much may be effected by floating away the principal part of the mossy substance; but where the mosses are not deep, or the soils under them of a good quality, after the making of proper drains, the best way is, probably, to ridge them in such directions and modes as are the most effectual in promoting the exit or passage of the stagnant water which they contain. Different materials may then be applied with the intention of improving their textures, and promoting the dissolution of the undecayed parts of the vegetable matters that are contained in them. The first may be accomplished by the application of various gravelly substances, sand, and coarse earth; and the latter, especially where there is a large growth of heath and other coarse plants, by the use of lime in its active or caustic state: but where such plants do not so much abound, alkaline substances, chalk, calcareous marle, the shelly kinds of sea sand, and the carbonate of lime, may be more advantageously had recourse to.

Shell marle, chalky substances, rich clays, and lime-stone gravels, being frequently met with under deep peat mosses, proper investigation should constantly be made by means of boaring them in various parts; as, in case any of these materials can be discovered at a suitable depth, such grounds may be brought into cultivation much more cheaply and conveniently, from their being applied more readily to the soft spongy surfaces of such soils, than where they are under the necessity of being carted upon them from considerable distances. Paring and burning is useful in both the above views, where the quantity of vegetable matters on the surface is considerable, and of the coarse kind; but the method of applying good earthy matter is to be preferred, where it can be procured in an easy and not too expensive manner.

Something may likewise be effected in the way of promoting the

fertility of these soils by cropping with particular sorts of vegetables. Those that have large branching stems, and which cover the surface of the ground very much, thereby excluding the action of the air in a great measure upon it, are constantly to be employed as the most advantageous and useful.

Vegetable Earth or Soil.—This kind of earthy material constitutes the superficial bed, or stratum, in which plants for the most part vegetate in every sort of soil; and differs very much in different places, from the variations that take place in its depth, and the greater or less progress that has been made in the several substances of which it is composed, to the stage of perfect decomposition or decay.

Some variety may, likewise, be caused by its being more intimately or more loosely mixed and blended with the other bodies that are found in soils. It seems probable, too, that the earthy matter which is formed from the destruction of some sorts of vegetable substances may be better suited for the purposes of vegetation than that which proceeds from others.

Vegetables, from their containing a considerable portion of mucilaginous matter in a state of mixture with their other substances, become, in some measure, capable of solution in water, though the external surfaces of living plants, on account of the resinous and animalized materials that enter into their composition, are protected from its operation. From the former circumstance, and that of earthy matters being contained in them, which had been taken up in the state of solution with their fresh juices while growing, it is evident that large quantities of vegetable mould must be continually formed and deposited on lands by the natural decay of such substances.

But the formation of vegetable mould or earth is further effected by means of the putrefaction or dissolution of such vegetables as are cut down, or otherwise destroyed, on the surface of the ground, and the application of various kinds of dung and composts. Where these have been in great abundance for a long time, there is mostly a deep rich surface soil of this earth; but where few vegetable products, and those of the less luxuriant kind, have been left to undergo the above process, or little assistance given by means of manures, the crust of surface mould is generally thin and poor. The resolution of vegetable matters is greatly promoted by a proper degree of moisture and heat, as well as a suitable state of the air.

In the process of the putrefaction of these substances, various chemical changes take place:—the water which they contain is decomposed; there is an absorption of the pure air of the atmosphere; heat is disengaged; and new combinations of the gaseous and saline kinds are formed. By these changes many substances are, therefore, converted to the use and support of vegetable life, that could not have been applied by any other means; besides, they are rendered much more extensively applicable than they could otherwise have been for that purpose.

The absorption of pure air from the surrounding atmosphere, or the process of oxygenation, is considered, by a late writer, as the chief cause of the retention of vegetable matter on the surface of the

earth, in deep peaty soils, and most others, but especially those that have been long in a state of tillage. The vegetable matter by this means being rendered less destructible, scarcely any of it is carried away in a dissolved state by rains, or the application of water in other ways; consequently accumulation must take place, which, under other circumstances, could not have been the case. The vegetable materials contained in soils, therefore, from their admitting different degrees of this process, and thereby becoming more or less insoluble, possess different powers in promoting the growth and nourishment of plants. Where they have been exposed to the action of the oxygenous or pure part of the air, for a considerable length of time, they are much more insoluble than where this has been the case for only a short period.

In order, therefore, to promote the formation of vegetable earth or mould, recourse must not only be had to such substances as accelerate the putrefactive process, but also such as have a tendency to increase the solubility of the vegetable mould or soil itself. The first of these purposes may be accomplished by the application of such materials as have been found useful in changing vegetable substances into the state of mucilage; such as the carbonate of lime, or effete lime, marle, chalk, aud calcareous matters in general, and also some earthy saline substances, as the refuse of salt manufactories, &c. The latter is to be attempted by the use of different alkaline substances; such as the ashes produced by the burning of various green vegetable materials, the urine of animals, the liquor of dunghills, night soil, and other animalized matters.

Vegetable mould may likewise be augmented by many other means; such as the growth of those kinds of crops that cover the ground much, and thereby produce a stagnated state of the air; the consuming upon the ground or the turning down of rich, full, and succulent sorts of green crops, by which a large portion of vegetable matter is quickly brought into the state of decay; and the destruction and evacuation of various sorts of insects that are prevalent in soils, by the application of substances of different kinds. And it is concluded that a superabundance of vegetable matter in soils, especially where it is much exposed to be acted upon by the oxygen or vital air of the atmosphere, is apt to render the ground too loose and open in its texture for the growth of most sorts of grain; winter corns in particular, from the sudden alternations of frost and thaw, being frequently thrown out of such soils and destroyed. Where this is the case, great benefit may be derived from the use of various saline matters, and lime in its effete state, as by such means the vegetable parts of the soil will be reduced to their proper and most productive state*.

* Dundonald on the Connection of Agriculture with Chemistry, p. 175.

SECTION VII.

Manures.

FROM the changes that are constantly taken place among bodies in nature, and the new combinations which are formed in consequence of them, a great variety of matters are unfolded, elaborated, and prepared for the nourishment and support of vegetable life.

Some of the substances which contribute in this way possess considerable fluidity and volatility, such as water and various gaseous materials, as oxygen, hydrogen, azote, and carbonic acid, in different states of combination*; and are chiefly formed and applied in the soils on which the plants exist or grow, and in greater or less proportions, according to the season of the year, the nature of the climate in regard to heat or cold, and the state or situation of the grounds in respect to its qualities; while others are more gross and heavy, and require to be applied and incorporated with soils, or spread out upon their surfaces, in order that they may produce their effects in promoting vegetation. It is principally to these, as being the means of sustaining different sorts of plants as crops, that the term *manure* has been given by practical writers on agriculture, though it is extremely obvious that they must undergo different changes, and be resolved into their more elementary principles, before they can be taken up and contribute to the increase and support of vegetables. In the various materials which the art and industry of mankind have rendered capable of being beneficially employed in this manner, there is great diversity; some are found to yield the matters which are necessary for the support of plants much more readily and more abundantly than others, as animal, vegetable, and all such substances as are rich in mucilage, saccharine matters, and calcareous earth, and readily afford carbon, phosphorus, and some aërial fluids, such as have been mentioned; while others that are greatly deficient in all or many of these principles, or do not readily part with them, are found to be of much less utility when employed in the way of manures. This is probably a principal reason why some sorts of manures, or substances, when put upon grounds, are so greatly superior to others used at the same time and in the same manner and proportion; a circumstance which is frequently noticed in the practical details of husbandry.

There are, however, many other ways in which substances, when applied to soils, may render them more fertile and productive, and contribute to the aid of vegetation. Some, besides furnishing such matters as are suitable for the purpose of promoting the growth of

* Light, heat, and probably electricity, are also necessary to the growth of plants.

plants, are known to add considerably to the quantity of vegetable and other matters contained in the soils on which they are placed, and thereby provide a more suitable and convenient bed for the reception of the roots of plants; others contribute little in this way, but operate chiefly upon such materials as are contained in them, breaking down their organization or texture, and thus setting at liberty different volatile and other ingredients, by which new compounds are formed, and brought to such states as are the most adapted to the support of vegetable life: others, again, act principally by producing certain changes and alterations in the constitution or texture of soils, such as rendering them more open and porous, or more stiff and compact, and by such means bringing them into the most proper conditions for the bearing of different vegetable productions; and there are still others that contribute in all or several of these ways at the same time.

From the great differences that are thus met with in the principles, or in the agency, of the matters that are made use of as manures, it becomes difficult to adopt that sort of arrangement which may be of utility in practice. That which serves to distinguish, in some measure, the nature of the materials from which they are derived, would seem to be of the most advantage in the cultivation and improvement of land: hence they may be divided into ANIMAL, VEGETABLE, FOSSIL, SALINE, and COMPOUND MANURES.

MANURES FROM THE DECOMPOSITION OF ANIMAL SUBSTANCES.—Substances of the animal kind, when reduced by the process of putrefaction, or other means, into a soft, pulpy, or mucilaginous state, are found by the experience of the most correct and able agriculturs, to afford those matters which are suited to the nutrition and support of plants, with greater readiness, and in more abundance, than most other bodies that can be employed. By chemical analysis it has been shown that the component materials of these substances, so far as agriculture is concerned, are principally water, jelly or mucilage, and saccharine oleaginous matters, with small portions of saline and calcareous earthy substances. Hence animal matters, though they agree, in some circumstances, with vegetable productions, each having, in common, water, saccharine and calcareous matters, are far more compounded; and in animal substances, some of these materials are in large proportion, while in vegetables they only exist in a very small degree; and the jelly, which in some measures resembles the gum and mucilage of plants, differs likewise from them, in its having much less tendency to become dry, as well as in its propriety of attracting humidity from the atmosphere, and of running with great rapidity into the state of putrefaction and decay.

All these principles of animal substances are resolved by their ultimate decomposition into other matters, such as the different gaseous fluids that have been mentioned above, carbon, phosphorus, lime, &c.

It would seem probable, too, that in animal substances of different sorts there may be differences in regard to the proportions of these several ingredients or principles; some kinds affording one or more of them, in greater abundance than others; while others again

are deficient in these, but abound in some of the others. On this supposition, the different effects of substances of the same class, when applied to soils of the same kind, may be easily accounted for.

Animal substances of every kind, on being deprived of their vital principal, have a quick tendency to take on or run into the state of putrefaction, a process which is considerably affected and influenced by the circumstances under which it is produced. But in the horny and more compact animal matters this tendency to putrefaction and decomposition is, under similar circumstances, much less rapid than in such as are of a less firm and dense texture. The process of putrefaction is, however, greatly expedited by the conditions under which it takes place being favourable; such as the substance, of whatever kind it may be, possessing sufficient moisture, being exposed to the free action of atmospheric air, and a moderate degree of heat. On various accounts it would likewise appear, that the decomposition of such substances may be promoted by moistening them with water slightly impregnated with common salt, and, perhaps, some other saline substances, such as the muriates of magnesia and soda, or sea-salt, as ingeniously suggested by the Earl of Dundonald.

It is probable also that the decomposition of some of the more hard and solid animal substances that are employed as manures, such as horns, bones, hoofs, and rotten rags, &c., might be greatly promoted, and rendered more immediately useful, by being reduced into much smaller particles than has been usually done, and by the application of higher degrees of heat than that of the atmosphere.

As the dissolution of animal as well as vegetable matters is known to be much impeded by their being excluded from the air, or exposed to such degrees of heat as are capable of drying up and taking away their moisture, and by the mixing of such earthy substances with them as are capable, from their open and porous textures, or vitriolic and other qualities, of depriving them of the fluid matters which they contain, we may see why, under certain circumstances of their being mixed and applied as manures, they may prove less beneficial than in other instances.

There are some other circumstances, beside those that have been mentioned, that render the decomposition of all such substances more quick and expeditious; such as their being lightly deposited together, and not in too large heaps, or with too much earth mixed and deposited upon them, by which the air is prevented from acting upon them so extensively as it might otherwise do. By sprinkling common water over them frequently, especially in hot and dry seasons, and where they are of the more hard and compact kinds, their dissolution, in many instances, might probably be rendered more quick and complete; and consequently the food or nourishment of plants be more readily and more abundantly supplied.

Hard Animal Substances.—In the matters of this sort that are employed as manures, there are considerable differences in respect to their texture and firmness, some being firm and solid, such as bones, horns, hoofs, shavings of horn, and some other similar substances, while others are more soft and pliable. The bones of all animals are capable of affording much nutritious matter to plants; but those which

are procured from cattle that have been killed when fat, are said to be the best for the purposes of manure. Those which have been boiled are far inferior, in this view, to those which have not undergone that process, as by such means they are principally robbed of their oily and mucilaginous properties, and consequently must yield much less nourishment to the immediate crop, whether it be grain or grass. All these sorts of substances require to be ground down in mills constructed for the purpose, or otherwise reduced into small pieces, before they are laid on and mixed with the soil, or formed into composts. The usual method is to reduce them to about the size of large filberts; but there can be little doubt that they would sooner run into the state of putrefaction if they were reduced into still smaller particles, and thus be made to afford their nutritive properties much more expeditiously, as well as more abundantly; by which means much less quantities would probably produce equally full effects with the large ones at present made use of, as, where the pieces into which they are broken are left large, they remain a great length of time in the soil, and are only gradually decomposed, without yielding that full supply of nourishment which is necessary for the supporting of crops. And when they have been even prepared in this way, too much earthy materials should not be mixed with or applied upon them; as, where this is done, by preventing the free operation of the air, their decomposition is greatly retarded. Nor should they, upon the same principles, when intended to be incorporated with the soil, be ploughed in too deeply, as by such a practice the crop will be deprived of much of the advantages which it might otherwise have obtained from such manure.

These substances are constituted of a considerable proportion of mucilaginous or gelatinous matter, a slight portion of fat, and an earthy salt composed of the phosphoric acid and calcareous earth. If great heat be applied, they afford a large quantity of hydrogen gas, carbonic acid gas, and a volatile alkaline liquor. From the nature of these different principles, it is evident that some sorts of substances may be blended and united with the reduced particles of bony matters, so as to promote their effects, as manures, in a considerable degree; such as lime, chalk, peat earth, and good vegetable mould, in suitable proportions, as by such means new combinations may be formed highly favourable to the process of vegetation.

The consuming of bony or horny substances by means of fire, for the purpose of obtaining their ashes, is a wasteful dissipating practice, that ought never to be attempted by farmers, as by it the mucilaginous and oily materials are driven off and lost, and nothing remains but a phosphate of lime, which can be of but little use in promoting the growth of vegetable crops.

Soft Animal Substances.—There are various matters of this nature that may be of use for the purpose of improving land as manures, some of which had been but little attended to by the farmer. Of this sort are *graves*, or the residuum which is left after the making of candles, and the *scum* which is collected in the boiling or refining of sugar.

Different trials, upon a small scale, with the former, have fully

convinced us that it is a substance that possesses great powers, when employed as a manure. And although it is a substance which is generally procured at a high price; from its going a great way, and being a lasting manure, it may, probably, be more frequently had recourse to than has hitherto been the case. It is mostly procured in the state of hard compressed square cakes, though sometimes in a soft condition, without having undergone any pressure. When in the former state the cakes must be broken down and reduced into as great a state of division as possible, which may be rather a troublesome and expensive process, except a mill, or some proper machine for the purpose, be employed. But when it has been even reduced to the finest state possible, it will still be improper for application as a manure, until it has been mixed and incorporated with a pretty large proportion of some rich earthy substance with which it may combine. In the attempts which we have had an opportunity of making with this animal substance after being much reduced, it has always been blended in the proportion of three or four parts of good vegetable mould, according to the condition of the land, to one of the graves, and then sown as a top dressing on grass land, where it has never failed to produce a full crop of hay, considerably greater than that by the usual dressings of dung, and a rich sweet after-grass, or such as cattle were remarkably fond of feeding upon. Dr. Wilkinson, of Enfield, conceives that the animal kingdom furnishes the strongest manures, among which he has found graves to be the most powerful and durable in their effects. From one ton to a ton and a half he considers as sufficient for an acre, according to the state of the land. The cakes in his practice are, he says, minutely divided, which on account of their hardness is an expensive and laborious operation; and even in this state of minute division, unless mixed with mould, they frequently prove too strong for corn, as he found by experience, on applying them to barley, the grain of which was injured by the rankness of the straw. They are, he conceives, peculiarly adapted to promote the growth of grass, turnips, and the leguminous plants.

Eight acres of pebbly loam were, he remarks, manured with dung, at the rate of ten loads of the common Middlesex carts per acre, except one acre of the poorest and most gravelly, which was dressed with a ton and a half of graves. The turnips where the graves were spread, and the succeeding barley (which were the crops on the whole piece), were thicker and more vigorous than where common dung had been laid. He has observed grass rendered so rank by the use of graves as a manure, that cattle would not touch it till mellowed by the winter's frost; and even in the succeeding year he was able to trace, by the superior verdure of the grass, to what extent this manure had been spread. He has also used with success, he says, salted fish provisions, and particularly herrings, which had been spoiled on ship-board, and has found them equal to the graves. In the same manner he has used salted meat that had become putrid on a long voyage. His generel mode of application has, he says, been to mix them with mould raised from the headlands of the field where they were intended to be spread, By letting them lie for some

time, the earth imbibes the strong smell and virtues of the animal manure. Over these he has spread, with advantage, the liquor drawn from the graves, and the washings of the casks of salt meat which had been spoiled. When sprinkled immediately over grass in the spring, he has also observed this liquor attended with considerable efficacy in producing a plentiful crop of hay.

Last year (1800) he says, he used with success a combination of lime and graves mixed with mould from the headlands, in the proportion of about fifty bushels of lime to a ton of graves. This composition, he observes, resembles *sugar scum*, which consists of lime and bullock's blood.

From the large experience he has had of the benefits arising from sugar scum, he thinks this combination of lime and animal matter deserves further investigation.

There can be little doubt but that by combining lime with animal substances, they may be rendered highly active as manures, especially when applied on soils that have a sufficiency of those earthy substances on which they can exert their full influence.

In this way they seem frequently to be rendered more active than when employed in a simple uncombined state; but experiments are perhaps wanting to fully ascertain the utility and best means of employing such matters.

Lime might thus be combined with bones or woollen rags, or with a compost of earth and night-soil; and would certainly greatly facilitate their conversion into manure, as well as render them more active in producing their effects in the support of vegetable crops. And by some of their properties being absorbed by the lime, during the time of their decomposition, and afterwards parted with more slowly in the soil, they may also by such means be, probably, rendered more durable and lasting, as manures.

There are still other substances of the animal class, such as the *refuse of glue-makers*, the *cuttings of fell-mongers*, the *clippings of furriers*, the *scrapings of oiled leather*, and the *chips or waste of shoe-makers*, which may be made use of as manures, when they can be collected in sufficient quantities. These animal materials, from their abounding in mucilage and oil, their great attraction for moisture, and their being readily soluble in water, contribute quickly to the support of vegetation, but are not probably so durable in their effects upon land as many other substances. Hence they should only be made use of with a view to the immediate crop, which, we believe, is pretty much the case in those places where they can be obtained in such quantities as to be employed for the purposes of agriculture.

Various animal substances of the fish kind, as the blubber remaining after the preparation of oil from the whale and other large fishes, and different sorts of small fish, both of the shell and other kinds, may be employed as manures; and also the offals of such animals, where they can be procured in a large quantity, as in large towns, sea districts, and where they are cured or prepared in great numbers for the market.

These substances may be readily reduced to that state which is proper for manure, by mixing with them a small portion of the car-

bonate of lime, and afterwards according to circumstances, a quantity, two or three times more than the whole, of good vegetable mould. Shell-fish, such as muscles, are commonly applied without being mixed with earthy matters; but this is certainly a wasteful practice, as much of their valuable principles is dissipated and lost, as is evident from the highly disagreeable stench that assails the neighbourhood of the ground on which they have been applied. By mixing good vegetable mould or peat earth with them, as has been mentioned above, the quantity of the manure would not only be greatly increased, but the offensiveness attending the use of such manures in a great measure corrected, and the effects of them in promoting the growth of vegetables probably rendered more advantageous.

The refuse of slaughter-houses and butchers' shops may, likewise, be prepared and made use of in a similar manner to that of fish. For as the manures that are formed from these animal materials are capable of affording much elastic volatile matters during their decomposition, they of course require to be well mixed and blended with such earthy substances as they can combine with and render soluble, and in proportions suited to their powers, in order to produce the most beneficial effects on vegetation.

It is probable that woollen rags, hair, feathers, and such like substances, from their having a less portion of oily or mucilaginous matter in their composition, are inferior as manures. The first must be cut or chopped into small pieces before it can be advantageously applied to the ground.

From the experiments that have been made with such animal substances as have been mentioned as manures, it may be inferred that their effects continue longer than those of many substances of other kinds. Dr. Hunter found from the application of reduced bones to a poor calcareous soil, with a grain crop, in the proportion of sixty bushels to the acre, that the crop was much superior, when this was used, to that which had not been dressed in the same way; and the grass crops afterwards for some length of time, on the same place, displayed a superiority, and appeared more early. He also found the same superiority in turnip crops in different fields, when dressed in the same way. Mr. Young likewise found the effects of bone manures to be very great; but they did not correspond to the quantities employed, as with twenty-five cart loads the crop was better than with fifty. This curious fact is, however, explained, by his observing that the soil was an extremely poor one, as in such a case there could only be a small proportion of earthy matter for the ammonia and other substances afforded by the decomposition of the bones to act upon, and reduce to that state of solubility the most adapted to the support of vegetation. Hence the immediate benefit that was derived from the manure, probably, depended solely on the oily and mucilaginous materials.

Where bony substances are not broken down into very small particles we suspect from some few trials that we have been enabled to make, that the effects of such substances will be equally, if not more, apparent the second than the first year, whether they be used

on grass land or that which is under the plough. The trials which Dr. Hunter made with ground and unground bones seem, likewise, to support this opinion, as he found that, for the immediate crop, the unground bones were of little or no service, but the ground ones of much benefit. What effect the unground ones had the second year is not exactly mentioned: however, from his concluding that these substances are, in general, upon grass land, more effectual the second than the first year, it may be easily supposed to have been the case.

Animal dungs.—The animalized substances that are, however, most generally made use of as manures, are the excrements of various kinds of animals, which are found in very different conditions, or states of preparation and richness, proceeding, in some measure, from the kind of food on which the animal has been fed, the matters with which they are incorporated, and the texture of the substances themselves.

It is stated by a very correct practical observer, that the dung of fat animals is unquestionably more rich, and consequently possesses greater powers of fertilization, than the dung of lean ones; and that the quality of the dung of every sort of animal will, in a great measure, be proportioned to the goodness or poverty of its food. Thus, when the animal is fed on oily seeds, such as lint, rape, and others of a similar nature, it will be the most rich; when kept on oil-cake, or those seeds which have been deprived of part of their oily matter, the next so; on turnips, carrots, and such-like vegetable roots, the next; on the best hay, next; on ordinary hay, next; and on straw, perhaps the poorest of all. The dung of lean hard-working cattle, feeding on straw, must, he conceives, be poor indeed.

Some manures of this kind, such as the soil of privies, is sometimes met with in a state fit to be applied to the ground, when not much mixed with fluid matter, such as urine. It most frequently happens, however, that it is in such a liquid state as to require other more solid substances to be blended with it, before it can be conveniently applied to the soil. In doing this, too little regard seems to have in common been paid to the choice of the most proper materials: but it is obvious, that such as can be the most fully acted upon, and the most readily converted into the states suitable for affording the nutrition of vegetables, by the principles of the matters thus employed as manures, must be the most adapted for the purpose, as well as the most beneficial. When, therefore, the manure made use of in this way is either wholly or principally constituted of such animalized matters as from their fluidity are in an improper state or condition to be set on land without having other substances previously mixed with them, such peaty, boggy, or black vegetable earths should be chosen as contain large proportions of matter, which the ammonia or volatile alkali so abundantly provided by the decomposition of such substances may exert itself upon, and reduce into that state of solubility which is suitable for promoting the growth of plants. By duly attending to this prac-

tice, which has been so scientifically handled by the Earl of Dundonald, much advantage may be gained, not only in the quantity but likewise in the quality of the manure.

The results of experiments attentively made in this way, indeed, clearly demonstrate that an inconceivable loss is incurred by the inconsiderate practice of exsiccating human excrement, as well as the negligent custom of permitting the liquor or fluid parts of dung-heaps to run away. The trials which we have been enabled to make also lead us to suspect, that it is a much more wasteful practice to apply these liquors to ground in their uncombined state, than in conjunction with such earthy materials as have been mentioned above. Besides, much of them must be imperceptibly dissipated by the process of evaporation, even when they are carried out in the most favourable seasons of the year; and they cannot in this way always be made use of on those soils that contain a sufficient quantity of those earthy materials, or principles, with which they can readily form combinations, and exert their most beneficial and fullest effects.

Most of the later practical writers on agriculture are decidedly of opinion, that the *soil of privies* is a manure of the most enriching kind, but that its effects are not so lasting as those of many other substances. In the trials which have been lately made with it, by a very ingenions and experienced agriculturist, it is said to have produced such astonishing fertility as to induce him to conclude that it exceeds all other sorts of manure that can be put in competition with it for the *first year* after its application. The second year he thinks it of *some* service, but in the third its effects nearly, if not quite, disappear. The circumstances which render this sort of manure so immediately active in promoting vegetation, and so quickly deprived of its beneficial influence, would seem to be from the great quantity of elastic principles which it contains in a loose state of combination, and the small quantity of earthy matter which it is capable of supplying to the soil, by the last stages of decomposition or decay. This also further shows the advantage of mixing and incorporating with it such kinds of earthy substances as it may be capable of acting upon and uniting with. From the causes just noticed, its most active and nutritious properties are almost immediately set at liberty, and either directly contribute to the growth of plants, or form such new combinations as readily become useful for the purpose, while but very little of the earthy material is left behind for further decomposition, and the durable aid of vegetable increase. The author mentioned above also further remarks, that this matter is not only prepared in the most suitable manner for the purpose of perfect vegetation, but that the herbage produced by it is capable of fattening the *largest* cattle in *less* time than any other. And we know from repeated experiments, that the finest garden vegetables may be produced by it, when properly employed, without the least injury to their taste, even in the most delicate of them, such as cauliflowers, white brocoli, &c. Instead of a bad taste being communicated to herbage by the use of this manure, it would seem, probably, that it considerably improves its flavour,

as it has been observed that the patches of such pastures as had been manured with this substance were constantly eaten *quite close* by horses, cows, and young cattle, while in other places there was much *longer grass*. From these facts, the importance of this substance, as a manure, is evidently such, that every possible means should be contrived to prevent its loss.

The dungs of those animals which feed on such sorts of food as constitute either wholly, or in a great part, the food of man, as has been noticed above, are found, from the experience of practical farmers, to be more effectual in promoting vegetation, when applied as manures to ground, than those of such animals as are sustained by such kinds of matters as are seldom or ever made use of in that way: hence it is obvious that the dungs of carnivorous birds, dogs, swine, horses highly fed, poultry, pigeons, and such-like animals, must be more powerful in their effects as manures, than those of horses when fed only with hay or grass, neat cattle, sheep, and other animals that live in the same manner. On the same principle, too, it seems not improbable but that the excrements of insects may be less efficacious as manures than their bodies, as it is well known that by their destruction and decomposition the fertility of land is considerably increased in particular instances.

It is probable, likewise, that the dungs of some animals may, from the state of their stomachs and other causes, as well as the nature of their food, be more completely reduced and animalized in its passage through their bodies: that this is the case, at least, in granivorous birds, in which the food is subjected to considerable trituration in the course of its digestion, there can be little doubt; and thereby they perhaps become, in some measure, in a condition more suitable to form new combinations, or afford the support of vegetation.

This view of the nature of the manures afforded by different animals should lead the practical agriculturist to be more attentive to the subject, in order that he may render them more abundant, and be capable of employing them under the most favourable circumstances; which cannot be the case while they are, as at present, indiscriminately mixed and blended in the common dung-heap. That they should not be used in this way is clear, from the contradictory accounts of them that have been presented to us by various writers and experimenters, which would seem to have been caused by employing them in states of mixture with other substances. By some it is asserted that one load of *swine's dung* is nearly equal to two of most other sorts, and that it is the richest of all animal manures: in this, however, they would seem to be mistaken; as, from trials made by others, it has been shown that *night-soil* is certainly to be ranked much before it. In some of the ingenious experimental attempts of Mr. Young, it is also shown that the dungs of rabbits and poultry are superior to that of pigeons, and greatly more durable. But poultry dung, in the comparative experiments of Mr. Arbuthnot, was found to be more effectual than that of rabbits, and that of the latter greatly superior to wood ashes. *Pigeons' dung* has, notwithstanding, been proved by much experience to be

a powerful and efficacious manure, and, probably from its abounding with volatile alkaline principles, been concluded to be of a hot or stimulating quality.

It is, however, from the larger animals that the farmer derives the principal part of the dung that is made use of as manure in the cultivation and improvement of land; the dung of such horses as are highly fed being found, as has been already seen, to be much more valuable for the general purposes of agriculture, and some uses in horticulture, than that which is made by horses when fed with hay or grass only. Where the animals are kept in the latter way, it is, probably, not so good as that of well-fed cows and neat cattle in general, as in these it may, perhaps, become more animalized from the circumstance of their food being more intimately blended with the *saliva*, or other juices, during the ruminant state of feeding in such animals. The dung of horses is, however, in common, much more disposed to take on the process of putrefaction, and cause more heat, than that of cows and other neat cattle; and indeed these are the chief distinguishing circumstances between them as manures. The dung of neat cattle may also, on account of its less disposition to run into the state of putrefaction, contribute more of the earthy material to the land on which it is applied. Hence, probably, its superior utility on the leaner and poorer or thinner sorts of soil. The dung and urine of animals when newly voided are not, except when the animals are morbid, in a putrescent condition, the length of time in which they remain in their bodies being too short for its fully taking place: but some degree of, or tendency to, putridity is constantly necessary to their discharge; and the means which are further suited to promote it in these substances have been fully described and explained above, in speaking of the nature of animal substances in general.

From the few experiments that have been made with the dung of sheep, it is evident that it is equally valuable with that of many other animals that feed in the same way; but agriculturists have not yet turned their attention sufficiently to the means of collecting and preserving it, so that it may be used alone as a manure. The method by which it is at present applied to land is by folding the animals upon it, under which method of management, on many soils, a great part of the advantage must be derived from the operation or action of the ammonia of their urine upon the vegetable matters contained in them, as well as from the consolidation produced by their treading.

Manures from the Decomposition of Vegetable Substances.—Vegetable as well as animal substances, when deprived of their vital principle or life, are soon rendered fit, by the separation, reduction, and ultimate decomposition, of their constituent principles, for the nourishment and support of new plants. In this process, which we have already seen to be greatly promoted in all kinds of substances by the materials being exposed to the free influence or agency of atmospheric air, moisture, and a middling degree of heat, various matters are set at liberty, by which different new combinations take place, that are capable of promoting

vegetation in different degrees, and upon which their utility as manures, perhaps, chiefly depends. The stages of this decomposition have generally been supposed to regularly succeed one another, from that which is productive of sweetness, through the vinous and acetous, to that which is the ultimate result of putrefaction. But a late philosophical writer ingeniously suggests, that it is more probable that different sorts and parts of organized matters, when dead, may undergo many different sorts of chemical changes, and that these may be different according to the differences in the degrees of heat, the quantity of water, and of air, to which they are exposed. He appears to have been led to this supposition from the saccharine process, preceding the vinous fermentation, which takes place in certain states of animal stomachs; and from what happens in the germination, or sprouting, of grain, by which the meally matter is converted into sugar. From remarking that the acerb juices of some kinds of fruit are rendered sweet by baking, he conceives that the saccharine process may take place in a degree of heat which is about that of boiling water, and that by it the process of fermentation may be altogether prevented from occurring. By destroying or injuring the life of fruits, it is also supposed that the saccharine process of their juices may be promoted, as is found in many instances; such as the ripening of fruits after being plucked from the trees; their being sooner ripened after being injured by insects, or other means; and after partially cutting, or otherwise injuring, the branches of the trees on which they grow; and this, which is termed the saccharine process, it is conjectured, may take place either beneath or upon the earth, in the incipient state of vegetable decomposition, before the vinous fermentation, and thus afford a very nourishing matter to plants.

In the vinous, or process which commences after the saccharine, carbon becomes united with pure air in a large proportion; and it is supposed, by the author we have just mentioned, that probably at the moment of their combination, while they are in the form of a liquid, and before they assume the gaseous state, they may be taken up by the roots of vegetables.

And as in the process of putrefaction carbon is not only changed into carbonic acid, but water decomposed, as is evinced by the smell of hydrogen, it is suspected that that inflammable substance may combine with carbon, as in the case of hydrocarbonate gas, and by this means render them both soluble in water, and thereby capable of being taken up as food by the roots of plants, without their passing into the acid or gaseous states. The union of azote with pure air, towards the close of the putrefactive process, by which nitrous acid is produced, it is likewise conceived may possibly tend to promote vegetation. This, however, may be promoted, from the circumstance of the pure air, or oxygen, adhering more loosely to its base, the azote, in the formation of this than other acids, and on that account yielding it more readily to the absorbent roots of vegetables. But, besides these means of supplying the nutrition of plants, as in the decomposition of vegetable substances by the process of putrefaction, the constituent principles of the water which they con-

tain are, as has been just observed, in some measure set at liberty; and the hydrogen, one of them, uniting with the azote which is afforded by the dissolution of vegetable matters, though not in such large proportions as by animal substances, forms ammonia, which from its ready union with fats and oily matters, and thus rendering them capable of being taken up by the absorbent roots of vegetables, may contribute to the support of vegetation. And in some instances, where saline insoluble earthy matters, or metallic salts, are contained in the soils to which manures of this kind are applied, or in which ammonia may be formed, it may decompose them, and by that means contribute to the formation of other new and less noxious compounds, or such as may be more capable of contributing to the growth of vegetables.

There is another substance which generally prevails in vegetables, and which is supposed, by the writer we have noticed above, to be a simple material, obtained in great abundance from the recrements not only of putrefying vegetable but animal substances, and calcareous earth, the latter of which he supposes to have been of animal origin in the early periods of the world. This matter, it is thought, when met with in the state of solution, may be taken up entire by the absorbent roots of vegetables, as well as occasionally formed and elaborated by them.

It seems probable from these statements, that different matters, fitted to the nutrition and support of plants, or crops, are formed and evolved during the different processes and stages of decomposition of vegetable as well as animal substances.

In vegetable productions the changes are, however, less rapid than in those of the animal kind, and probably much more varied, according to the various states and textures of the particular substances; for it is obvious, from numerous facts and circumstances, that the more luxuriant and juicy vegetables are much more readily decomposed than such as are dry, and have a ligneous structure. Hence it is that fresh vegetable matters are much more quickly converted to that state of decay which is suitable for the supplying of vegetable nourishment, than such as straw, hay, wood, and other dry materials of the same nature.

It seems likewise probable, that some vegetable matters may yield some of the substances that are taken up by the absorbent roots of vegetables in much larger proportions than others; as it has been found that different sorts of grain vary considerably in the proportions of mucilaginous, and what is termed vegeto-animal matter, which they contain; and that grain, potatoes, carrots, and many other roots of the same kind, on being consumed in the open air, afford much larger quantities of alkaline salts than hay, straw, or wood: it is undoubtedly from these and similar causes, that some sorts of vegetable matters, when reduced by means of putrefaction, are found to be so much more effectual as manures than others, when applied under the same circumstances, and to soils in every respect similar.

There is also another circumstance which seems necessary to be attended to in substances of this class; which is, that in general,

when resolved by the ultimate process of putrefaction, they yield larger proportions of earthy materials to the soils on which they are deposited than most substances of the animal kind, and consequently add more effectually to the staple of the land. And as this vegetable mould, or earth, from various causes, is constantly becoming more extensively, and more intimately, blended with the other materials of the soils, and, of course, forming new combinations, by which some of those matters which serve for the nutrition of plants are set at liberty, and brought into the state most proper for being absorbed by the roots of vegetables; we see why those manures, which are principally composed of vegetable substances, are more durable in their effects than such as are prepared from many animal materials.

The substances of the vegetable kind, may be advantageously converted into manure, are so extremely numerous that it is impossible to describe the whole of them. All kinds of green vegetable productions may be employed in this way; such as the luxuriant weeds of rivers, lakes, ponds, and ditches; fern; and the refuse of different kinds of garden vegetables. Where green materials of this nature are made use of, they should always be cut down while in their juicy state, just before their flowers begin to appear, in order that they may be in the most suitable condition for becoming quickly putrid, and to prevent the injury that might otherwise be sustained from the vegetation of their seeds. They are afterwards to be collected into heaps of a moderate size, and their putrefaction promoted by their being thrown together as lightly as possible, and the occasional sprinkling of them with water, if the season be hot and dry: and as lime is found, when applied to vegetables in their green moist state, to disengage from them both hydrogen and azote, by the combination of which volatile alkali is produced, it may be advantageous to blend a portion of lime at first with the heaps, and afterwards add a suitable quantity of peat earth, or good vegetable mould, for the alkali thus formed to act upon. By this method, the quantity of manure from such substances may be greatly augmented, and rendered more valuable. But when dry materials, such as hay, straw of different kinds, fern, and rushes, such additions cannot be had recourse to with eqnal success, unless where much of the dung and urine of animals has been incorporated with them; but their resolution and decay may be greatly promoted by their being kept in a state of moisture, without the water being suffered to stagnate upon them, and by their not being permitted to be trodden down too much by cattle, or other means, in the farm-yards.

Another beneficial means of vegetable manure, which is yet far from being sufficiently practised, is that of providing full crops of succulent green vegetables, such as clover, buck-wheat, tares, vetches, spurry, pease, beans, turnips, and many other similar plants, to be turned down by the plough, in order that they may undergo the putrefactive process under the ground, and by that means be converted into manure, and supply the nutrition of plants. In this practice it is probable that great advantages might

be obtained on the principles which we have just stated, by the spreading of a small portion of lime and peat, or rich vegetable earth, over such crops, and then rolling them down that they may be completely turned in and buried by the plough; an operation which should be performed as quickly as possible afterwards, and, where the crops will admit of it, in the summer or the early part of autumn, while the sun has the power of promoting the decay of such vegetable matters. By this means, it seems probable that the putrefaction of such crops would not only be much expedited, but the principles thereby set at liberty be capable of exerting their influence much more extensively than where the plants themselves are only employed, and little additional expense be incurred by the farmer.

Sea-weed * is another vegetable production which is capable of being employed as a manure with great advantage, and should never be neglected where it is within the reach of the farmer. In some places it is the practice to spread it upon the lands as soon as possible after being cut from the verges of the rocks on the different sea-costs, or collected after being left by the tides, and to plough it in: where this method is adopted, as little time as possible should be suffered to elapse after the cutting, or collecting, of the weed, before it is ploughed down: for, as the plant in its green or succulent state readily decays and becomes putrid, if there be any considerable delay in the performance of the business, especially when the weather is hot, much of its valuable properties as a manure is dissipated, and carried away by means of evaporation, as is sufficiently evinced by the pungent and disagreeable smell that issues from it on its being thrown upon the land while undergoing the process of putrefaction: and besides, when it is suffered to become dry and hard before it is turned into the ground, the parts of it that remain are considerably longer before they become decomposed and reduced into the state suitable for affording the nourishment and support of vegetable crops. It is most probably on these accounts, as well as that of the weed affording but little earthy matter in proportion to its bulk, on its decomposition, that it is found, in general, to be less permanent in its effects, as a manure, than some other vegetable matters. Something may likewise depend on the goodness and luxuriance of the weed itself, and the state which it is in when gathered from the shores, or cut from the sides of the rocks. This, like most other plants, will undoubtedly be in the most proper condition for the purposes of being converted into manure, when cut or collected in the most succulent state of its growth.

Another practice, which prevails in some districts where this weed is employed for the purpose of manure, is that of collecting it into large heaps, and letting it remain exposed in that state to the influence of the weather until it be completely rotten, and in a condition to be put upon the land; but as the plant contains in its composition a large proportion of saline matters, which during the state of its decomposition, or decay, are brought into activity, it

* *Quercus marina.*

is obvious that by such a method of proceeding much loss must be sustained, not only from the dissipation of the volatile and more fluid parts by the action of the sun and wind, but by the rain's dissolving and carrying away the saline materials that have been formed. When this weed is, therefore, not to be immediately applied as a manure, it would seem to be the most œconomical and advangeous plan, especially where the weed is fresh, to first blend a portion of quick-lime with the heaps, and then have a sufficient quantity of fresh good earth, mould, or other similar matters, placed beneath them, as well as mixed with and covered over them, in order that the substances afforded by the dissolution of the weed may not only have something to mix with and act upon, but likewise be prevented from being washed away by rains. By this means the quantity of manure may be very much increased, and its effects rendered considerably more permanent.

In the islands of Jersey and Guernsey, where this weed is extensively employed as a manure, it is cut in the early part of the spring and about the month of July; the first cutting is, in most cases, immediately made use of as a manure for barley and pasture lands, but the latter principally converted to the purpose of fuel, the ashes only being employed as manure. By this practice of consuming the plant in its dry state, however necessary it may be in these islands, from the great scarcity of fuel, the loss in respect to manure is extremely great, as the quantity of ashes that are thus produced bears but a very small proportion to that of the weed which is consumed. The weed which is collected after having been thrown upon the shore by the tides, is found to be much inferior as a manure to that which is cut from the rocks and made use of in its juicy state; which fully confirms the opinion that has been advanced above.

Bark, which has been made use of for the purpose of tanning leather, may likewise be employed as a manure: when used in this way it should be collected into moderate-sized heaps, before it has become dry by too much exposure to the heat of the sun and wind; and then by having a quantity of lime mingled with it, and being kept slightly moistened with water, its putrefaction and decay may be greatly promoted. When intended to be applied to grass lands, it should be considerably more reduced towards the state of vegetable mould, than when made use of for the purpose of supporting arable crops.

As during the decomposition of this substance much heat is produced, and many elastic matters set at liberty, it would seem that as a manure it is more adapted to the stiff, cold, and heavy soils, than those of the lighter kinds; a fact which has, we believe, been confirmed by the experience of most agriculturists.

The mud taken from the bottom of rivers, ponds, and other places, where water has stagnated for some length of time, fresh or maiden earth, and the scourings of old ditches, are substances that may frequently be employed with advantage as manures, being principally composed of the recrements of decayed vegetable matters. They should not, however, be put upon grounds, especially those under grass, until they have been reduced into a considerable degree of fineness, by means of frequent turning over, and the mixing of a

portion of lime, rotten dung, or other materials of the same kind, with them, in order to promote, and render more full and complete the decay of the more solid parts. In using manures prepared from substances of this sort as top dressings for grass land, they should not be spread on too thickly, or in too large proportions at one application, as where that is the case great injury is often done to the succeeding crop, the grass not being able to spread itself completely over the surface.

The dust which is screened from malt, mixed with the tails, usually denominated *coombs*, where they can be procured in large quantity, as in the malting districts, may be converted to the purpose of manure. It is observed, in a paper by Mr. Farey, in the Annals of Agriculture, that the black malt dust, such as falls through the kiln-plate in the operation of drying, is greatly preferable to the white, on account of the seeds of charlock, with which it abounds, being destroyed by the heat: but besides this, the heat thus applied may, by destroying the vegetative principle of such seeds where they exist, render them and the dust more readily disposed to take on the process of decay and become putrid, and thereby afford the nutrition of vegetables more quickly, as well as more abundantly. This, as well as saw-dust, where they can be had at a cheap rate, may be considerably improved as manures, by incorporating them, in pretty large quantities, with the dung and urine of animals, as by strewing them in the bottoms of poultry and pigeon-houses, dung-heaps, and necessaries; and also in the bottoms of reservoirs into which the urine of cattle and soap-suds after washing are emptied: from the action of these matters upon them, they are found to become more quickly in a state to be used with advantage as manures. Manure of this sort has been found very beneficial when applied in the proportion of four quarters to the acre, sown with the crop for which it is employed.

The husks, or cakes, which are left after different oily seeds, such as those of rape, cole, &c. have been subjected to pressure in mills in order to obtain their oil, may also be used as manures. These substances are generally prepared for application by being reduced into the state of coarse powder, by mills or other suitable means, and then sown by the hand, and harrowed in with the seed of the crop for which they are used. Some agricultors, however, recommend their being mixed, when thus reduced, thinly, with the materials of such dunghills as are deficient in point of richness, as where they have been made by lean stock with a large proportion of litter. On turning over heaps of this kind, about a ton of oil cake should be well and evenly mixed with every twenty or thirty tons of the dunghill compost: by this practice a rich and good manure is said to be formed. The success of these substances, when made use of alone as manures, has been found to depend, in a great measure, upon the falling of rain soon after they have been put upon the land, as in dry seasons little benefit has been derived from their application. The reason of this seems to be, that as the cake when used is mostly in an extremely hard and dry state, it does not undergo that decomposition which is necessary, until it has been moistened by the rain;

by which it is rendered capable of running quickly into the state of putrefaction, and consequently of affording such matters as are suitable for the support of plants. When applied without being incorporated with other substances, it is mostly laid on to the amount of four or five quarters to the acre, according to the condition of the land.

The refuse or pulp of pears and apples, which have been ground, and the liquor squeezed from them, may likewise be converted to the purpose of a manure in the cyder districts. When employed in this way, however, some heavy substance, such as a good earth with a little dung, should probably be mixed with it before it is put upon the soil, as by being blended with such materials it may be more conveniently and more extensively applied.

Manures from the Agency and Decomposition of Fossil Substances.—Substances of the calcareous kind, which are to be considered under this head, produce effects more or less powerful in promoting the growth of vegetable crops, in some measure, according to the state and quantity in which they are applied, the nature of the soils on which they are employed, and the properties of the matters with which they are combined. For though calcareous materials have been made use of as manures for a very great length of time, and been applied in various ways, difficulties still remain concerning the manner of their operation, in many cases, which seem principally, however, to proceed from the want of proper discrimination in respect to the state of the different calcareous substances at the time of their application, and their being made use of to different soils, without a sufficient distinction of the properties of the materials of which they are constituted or composed. On all these accounts, therefore, though lime may be produced from chalk, marble, different lime-stones, coral, and shells, by subjecting them to such degrees of heat as are necessary to expel or disengage the carbonic acid or fixed air that they contain, which is apparently of the same quality, it may vary in its effects when employed in agriculture.

Lime, when newly burned, or before it becomes loaded or saturated with the moisture and carbonic acid, or fixed air, contained in the atmosphere, which, from their strong tendencies to combine or unite with it, generally soon takes place, is, in its most active state, and from the power which it possesses of breaking down and destroying the texture and organization of such animal and vegetable substances as come in contact with it, termed *caustic* or *quick* lime. When applied, under these circumstances, to grounds which abound either with fresh vegetable matters, or such as have undergone some degree of change by being buried in the soil, (as in moory and heathy mountain land, peaty and boggy earth, and all such soils as have long remained in their original uncultivated state, covered with a variety of coarse plants,) it is found to produce beneficial effects; in the first case, probably, by its ready action on the different materials of the green plants, by which it disengages from them hydrogen and azote, from the subsequent combination of which ammonia or volatile alkali is produced, a substance which has great power in promoting vegetation, as is evinced in cases where substances that

contain this matter in large quantities are used as manures; and, in the second place, by its combination with the carbonaceous matter of such soils, or with that of the various animal and vegetable matters which are contained in them, in some of the stages of their putrefaction or decay, and by this means rendering it soluble in water, and thereby capable of being taken up as food by the absorbent roots of vegetables: and though lime in its pure or caustic state retards, in some degree, the process of putrefaction, especially when used in any large quantity, it is probable that by its power of corroding and dissolving the hard and fibrous parts of vegetable and other matters, as is shown by its quickly reducing the ligneous particles of bark, which has been employed in the process of tanning, to the state of mould, it may bring the abundant vegetable and other materials contained in such sorts of land, quickly into that earthy condition in which they afford the nourishment and support of crops, which by the processes of putrefaction, and insect digestion, could only have been performed in a very slow and gradual manner. Pure lime, too, from its well-known property of destroying different kinds of insects, such as worms, snails, slugs, grubs, &c., which are mostly abundant in rich fresh soils, may furnish much nutritious matter for the purpose of vegetation. And from its having a greater tendency to combine with mucilaginous oily matters than with fixed alkalies, a kind of calcareous soap may in some cases be formed, that may contribute, in its liquid state, to the nourishment of plants.

When pure lime is mixed with clayey soils which do not possess too great a degree of humidity, it is likewise capable of rendering them less stiff and tenacious, consequently more suitable for admitting the small fibrous roots of vegetables, not only by the evolution of heat and other elastic matters, during the period of its becoming saturated with the moisture and fixed air, or carbonic acid, which they may contain, but also by being thereby most intimately and minutely mixed with them, from the fine impalpable powdery state to which it is necessarily reduced. Where, in such soils, the sulphuric acid abounds, it may likewise produce good effects, by forming with it a kind of gypseous compound, and, where other acids are present that are prejudicial to vegetation, by the power which it possesses of neutralising them.

And where the lime has been burnt from the magnesian limestone, it may probably be serviceable when applied to clayey or other soils that contain the sulphuric acid, which are usually denominated sour lands by farmers, by forming a sort of Epsom salt in the ground; a substance which the experiments of Dr. Home have long since shown to be highly favourable to vegetation when used in small quantities.

Lime, on exposure to the atmosphere for some time, undergoes a considerable change, being rendered mild by the absorption of carbonic acid or fixed air from it. In this state of combination it is termed, by modern chemists, *carbonate of lime*, or *effete* lime; its power or capability of acting upon, and destroying or breaking

down, the texture of organised bodies being greatly diminished. It still, however, promotes their dissolution and decay, by aiding and forwarding the natural process of putrefaction, as is sufficiently proved by those compost dung-heaps, with which it has been mixed, becoming much more quickly in the state to be applied to land than where no such ingredient had been employed: by this means it therefore contributes greatly to the support of vegetation; and it has been lately observed, that where incorporated or blended with such composts of soil and manure as are in the state of generating nitrous acid, it arrests the acid as it forms, by which means a calcareous nitre is produced, and thus the exhalation and ready escape of a nutritious material is guarded against and prevented.

The combination of lime with carbonic acid, by rendering it soluble in water in its fluid state, without being expanded into gas or vapour, may likewise supply much carbonaceous matter for the support of vegetation, as has been ingeniously conceived by the same author. The property possessed by lime, of supersaturating or overloading itself with moisture, attracting or drawing it away from the air in contact with the surface of the ground and the earth underneath, and, after depriving them of it and the carbonic acid which they contained, permitting them to escape again, as has long been observed in the case of new-plastered walls, may also be of considerable utility when it is applied to the more dry and sandy sorts of soil, by affording moisture and such aërial matter to the roots of the vegetable crops; which it is capable of supplying in a very equal and extensive manner, from the extreme state of pulverisation to which it is frequently reduced when slaked by the dampness of the atmosphere or very gentle rains.

Besides these modes of promoting the growth of vegetable crops, it has been supposed that calcareous earth, by containing phosphorus, may also be useful, as by its union with it a kind of hepar may be produced, and the phosphorus thereby rendered soluble in water, without becoming an acid by means of its combination with oxygen or vital air. Phosphorus is conceived to be probably as necessary an ingredient in vegetable as in animal bodies, as is evident from the phosphoric light seen on rotten wood in some of the stages of putrefaction; in which it is imagined, the phosphorus is set at liberty from the calcareous earth, or from the fixed alkali, or the carbon of the decomposing wood, and acquires oxygen from the atmosphere, both warmth and light being emitted during their union. And it may, it is further observed, perhaps more frequently exist in the form of phosphoric acid in vegetables, and be thus readily combined with their calcareous earth, and may be separated from its acid by the carbon of the vegetable during the time of calcination, and also in the process of putrefaction.

This view of the nature and properties of lime shows that it may be employed, in one or other of its forms, more generally to soils than has been supposed by agricultural writers. It should, however, never be made use of without duly attending to the nature and constitution of the soil on which it is to be applied, as upon this

circumstance its success will, in a great measure, depend; and it is, perhaps, only by it that the proportion, the state, and the manner of its application can be advantageously directed.

It is evident, from the various trials that have been made by practical farmers, that the more intimately and the more minutely lime is blended and incorporated with the soils on which it is applied, the more full and complete are the effects which it has in supporting the growth of different sorts of crops. Thus it has been remarked by a very intelligent writer, that "if a heap of lime of a considerable thickness shall have been ever so long on one spot, and be afterwards carried clean away from it, so that none of the particles of the lime remain to be mixed with the soil, that spot will not be richer, or carry more luxuriant crops, than the places around it; which every one knows is not the case with regard to dung. And again; that "if lime be spread upon the surface of the soil, and allowed to remain there without being ploughed in, its effects will scarcely be perceived for several years, till it has had time gradually to sink through the sward, and mix with the soil; after which its effects begin to be perceived, although much less sensibly than if the same quantity of lime had been intimately mixed with the soil by means of the plough and harrow." He observes, that he is not a stranger to the improvements that have been made in Derbyshire by means of lime, without the plough; but this is no exception, he thinks, to what he has said. The effects are slow, though certain. Those who inhabit countries that admit of the plough are often, he says, advised to lay lime upon the grass, and are made to believe that their pasture will be instantly mended by it, nearly in the same perceptible manner as if it had been dunged. This he has tried, and has seen it tried by others; but always found that the grass for the first year was rather hurt than benefited by it; nor was it so much improved in succeeding years as if the same quantity of lime had been applied, and intimately mixed with the soil. In this mode of applying lime, it is long, he thinks, before it yields a proper return; and is not to be recommended to a poor man, unless where necessity obliges him to practise it.

On these grounds it is likewise conceived, that lime may be employed much more advantageously, when made use of even in small proportions, than such calcareous substances as have been reduced into the state of powder without calcination. It is well remarked, however, by the same author, that much must depend on the mode in which the lime is applied. "If," says he, "it is spread as soon as it is slaked, while yet in a powdry state, a very small quantity may be made to cover the whole surface of the ground, and to touch an exceedingly great number of particles of earth; but if it is suffered to lie for some time after slaking, and to get so much moisture as to make it run into clods, or cake into large lumps, it can never be again divided into such small parts; and therefore a much greater quantity is necessary to produce the same effect than if it had been applied in its powdry state. But if the soil is afterwards to be continued long in tillage, as these clods are annually broken smaller by the action of the plough and harrows, the lime must continue to

exert its influence anew upon the soil for a great course of years; and it will produce an effect nearly similar to that which would be experienced by annually strewing a small quantity of powdered lime over the whole surface of the soil: but as the price of the lime must, in the first case, be paid by the farmer altogether at the beginning, which only comes to be successively demanded in the other case, this deserves to be attended to, as it may become a consideration of some importance where lime is dear, and money not very plentiful."

There is another circumstance that requires to be considered in respect to the application of lime, which is, the quantity that may be necessary to be employed. The opinions of practical writers are much at variance in regard to this point, some contending that a small quantity only can be applied with safety and advantage, while others maintain that scarcely too great a proportion can be made use of. It is obvious, however, from the differences that take place in soils, that no particular proportion can be suitable in every case, but that it must be varied very considerably according to the circumstances that have been already stated, as well as from the situation or condition of the land on which it is laid, and the proportion of *real* calcareous matter that may be contained in the lime that is to be applied. As it has been shown that lime, when in its most active state, soon becomes reduced so as to be perfectly mild, by its property of absorbing moisture and the carbonic acid from the air, there can be little danger of injury from its caustic quality, though it may, on its first application, have a tendency to unite with and destroy such green or other vegetable productions as may be present.

It is remarked, however, by a late practical writer, that "most kinds of *stone-lime* should be applied with a sparing hand, and with a considerable degree of caution, as the *caustic* quality is many times greater in *this* than in lime made from chalk." He has had many opportunities, he asserts, of seeing total barrenness induced by *a too liberal use of it*; very generally at the several places where the carts were stopped for the men to spread it, at the bottoms of every heap, and once an entire close.

It has been employed in different proportions, from one to six or seven hundred bushels on the acre, on various sorts of soil, by some very accurate agricultors, under similar circumstances, with benefits in proportion to the quantities applied in augmenting the fertility of the soil. And accidental experiments have demonstrated that it may be used in still larger proportions with advantageous effects. In short, it is concluded by this writer, that, "on soils which do not naturally abound with chalk or other calcareous matter, there is less danger in giving too much lime than in applying too little, except in those cases where an over-luxuriance is dreaded."

It has been asserted, that lime never contributes to increase the fertility of soils, but that it has deteriorated them greatly by promoting their over-exhaustion. This seems, however, difficult to explain, when the nature of its properties is fully considered; and it is more probable that such an effect may have proceeded from injudicious cropping, and improper cultivation, than the operation of

the manure, especially as it has been employed in many well cultivated districts very extensively, and for a great length of time, without any disadvantage of such a nature having been experienced.

The duration of the beneficial consequences of the use of lime in promoting the growth of vegetable crops must be different, according to the differences of circumstances in the land to which it is applied, the proportion of it that is employed, the kind of crop that is cultivated, and a variety of other causes of the same nature. But it is evident, from the facts that have been stated by practical writers in respect to its continued powers of predisposing lands on which it has been laid to the growth of particular sorts of crops in preference to others, and of rendering the operation of other kinds of manure, and other methods of culture, more effectual than where it has never been used, that it must produce very useful permanent changes in the soils to which it is applied. An additional proof of this is likewise met with in the well-known circumstance of the quality of the grain from such lands as have been limed being much improved, having a thinner skin, and yielding much more flour than from ground where it has never been made use of; which is ingeniously supposed, by an able author, to proceed from its containing more starch and less mucilage, on account of the tendency of the lime to promote the conversion of the latter substance into the former, by hastening the ripening of the seed.

This also shows the importance of this sort of manure in those kinds of land that are late in bringing their grain crops to perfection, whether from their particular nature, or the situations in which they are placed.

Lime has been sometimes objected to as a manure for tillage lands by agricultors, on account of its supposed tendency to sink down in the soil below the reach of the plough, and thereby becoming of no utility. This can probably, however, only be the case where the lime has not been sufficiently burnt, or afterwards, on its application, properly reduced into a powdery state, and spread out equally over the land; as where these points have been well attended to, from its having considerably less specific gravity than most soils, no such consequence can take place; the fine particles of the lime, from their being so very minutely intermixed and blended with the earthy materials, not having any disposition to sink down through the superficial stratum of mould: but when applied in a coarser and less reduced state, from its dry quality, and that of its not intimately combining with the particles of the soil in the way of animal or vegetable manures, it may occasionally fall down, when collected on the surface, during the time of reiterated ploughing, or otherwise stirring the ground, and rest upon the more stiff and firm subsoil below the track of the plough.

On these accounts it may, therefore, be necessary in the application of lime, to pay greater attention than usual, not only to the preparation, but likewise the reduction of it into the most perfect powdery state, as well as the spreading it out over the land with the greatest equality when dry and free from lumpiness. It may also be of advantage, where it has been laid on the surface of land, espe-

cially the grass kind, to plough the first time after such application with but a light furrow, as by this means the portion that may fall down in the way mentioned above, will not merely be prevented from getting to such a depth as may render it useless, but be more intimately incorporated with the soil by subsequent ploughings.

It is probable that the differences in the modes of applying this substance to stiff adhesive soils, may have caused the great diversity in its effects which have been so frequently noticed by practical writers.

As we have seen that there are considerable differences in respect to the purity or goodness of lime stone, or other calcareous matters, it is obvious that there must be much variety in regard to the lime that is produced from them. Where it has been prepared from the purer kinds, when brought into the state of powder by being saturated with water, it is perfectly soft, smooth, and impalpable; while in other cases it feels coarse and gritty, according to the different degrees of impurity. In general, so far as the purposes of agriculture are concerned, that lime which has the greatest levity, is the softest and smoothest to the touch, and has the whitest colour, is the most advantageous.

In the carriage of lime for the uses of the farmer, it may sometimes be necessary, where the distance is considerable, to pay attention to the nature or state of it, as without that much expense may be incurred to no purpose. When the lime is pure, it will be the most œconomical method to convey it in the state of shell, as by that means nothing will be carried but what is useful; whereas, if it were carted in a slaked condition, a large proportion of water and other matters must be conveyed with it. But where lime is impure, and adulterated with other substances, or imperfectly prepared, it may be a more saving method to carry it in the state of powder; otherwise much matter may be conveyed that will never slake or fall down into lime.

Lime may be employed in many different kinds of soil with advantage, when proper attention is paid in its application; but in its more active states it has been shown by experience to be the most useful on those moory, peaty, heathy, and other soils which contain a large portion of coarse vegetable matter.

From what has been observed, it seems probable that lime, besides exerting its influence, when united with soils, in reducing the materials which they contain into the state or condition suitable for affording the nourishment of plants, and rendering them more proper for their reception, by altering their textures, or removing such qualities as are noxious, is capable of supplying such matters as contribute to their growth and support. On this account it probably is, that it has been found by experience to be equally, if not more beneficial on poor than on rich soils; and that it requires to be mixed and incorporated with but a small portion of earth or mould, to render it highly productive.

Lime-stone, and other hard calcareous substances, without being subjected to the process of calcination by heat, may, in many cases, as where fuel cannot be procured to burn it into lime, be beneficially employed for the amelioration of land, as has been shown by the

experiments of Mons. Du Hamel and others. When thus used, it should be well pulverised by such mechanical means as can be cheaply performed; much of the advantage to be derived from it probably depending upon its being reduced into a considerable state of fineness, by which it may be more minutely blended with the soils on which it is applied, and thereby act upon and afford nutritious principles more extensively for the support of crops; and at the same time render the heavy and more cohesive soils lighter, by being more uniformly incorporated with their clayey and earthy materials. But as calcareous substances can never be reduced, by any sort of machinery, to the fine powdery state to which they are capable of being carried by means of calcination, it is probable that when employed upon land, they will be less beneficial in many cases, than when used in the state of lime. It is on the above principles too, most probably, that the scrapings of roads, made with calcareous and other substances, are found so beneficial in different instances, a large portion of them being in the state of an extremely fine powder from the attrition of the wheels of carriages and other causes. Such lime-stones as contain the largest proportions of argillaceous earth in their compositions, when employed in this reduced state, will be the most proper for the thin light soils; as by that means the staple of them may be increased to the great advantage of the crops. In the application of this sort of material to land, the farmer should constantly be attentive to the state or condition to which it is reduced, as well as the nature of the soil, and put it on in such proportions as may be most suitable to them.

Lime-stone gravel, a substance which has been successfllv laid upon land in Ireland, and which is a kind of stony marle, might most probably be equally or more beneficial in considerably less quantities, if the stony lumps which it contains were first more perfectly reduced; for it has been remarked, that where the pieces are large, a much greater proportion is required, and the effects are slower, than where they are small.

Chalk is another material of the calcareous kind which is capable of producing good effects on land when applied in a suitable manner in its uncalcined state. From its having a portion of argillaceous or clayey matter united with it in some cases, it partakes of the nature of marle. Where it is made use of to the more stiff, clayey, loamy, and heavy sorts of soil, it should, in most cases, be as much pulverized and reduced as possible before it is laid on, in order that it may be spread with greater exactness, and be more regularly mixed and blended with the stiff and compact materials of such lands; from which they may be rendered more capable of admitting the fibrous roots of vegetable crops to spread themselves in them, and thereby take in more perfectly the nutritious matters which are presented to them. That this practice is of much utility and advantage is evident, from the circumstance of farmers, in most of the districts where chalk is employed as a manure, finding that it is considerably more beneficial when made use of in the spring, after having been dug up in the autumn and exposed to the frost and

moisture through the following winter, and by that means much pulverised and broken down, as well as by their carefully breaking and reducing the larger pieces. It would probably, however, be a still more advantageous practice to break it down, and apply it as quickly as possible after digging it out of the pit; as by leaving it exposed to the atmosphere for some length of time, it not only becomes hard, but likewise less soluble, and therefore less proper for the purposes of manure. Hence it probably is, that farmers, where the chalk husbandry is practised, find the dressings more efficacious when the chalk is dug from a considerable depth than where it lies near the surface of the ground. In the dry and light soils too it may, probably, be more serviceable in this reduced and powdery state, from the circumstance of its possessing more moisture, on account of a more extended surface being exposed to the air, and the particles of the soil, from which it may absorb and attract it, and afterwards part with or afford it in a more regular and uniform manner to the absorbent roots of the growing vegetable crops. The observations of practical farmers, however, invariably show, that on such soils it is much more beneficial when made use of in the form of compost, either with rich peat or vegetable earth and mould, or with good dung; as by this means a great defect in such kinds of land, the want of well reduced vegetable matter, is remedied, and a greater proportion of nutritious materials afforded for the support of crops.

When this manure is employed upon the more wet and poachy kinds of ground, there is probably not the same necessity for its being reduced to a great degree of fineness, as it may be apt, under such circumstances, to dissolve and sink down too much, by being so greatly diluted with water, while in the rounder state it may be retained nearer the surface, and thereby be capable of absorbing and taking away the superabundant surface moisture more effectually. But even in such soils, where the principal intention is the destruction of moss, rushes, and other coarse plants, the growth of which depends upon a great degree of superficial wetness, it may be employed most advantageously in a state of considerable reduction; as from its greater readiness to sink down, it may the more quickly take away from their roots the excessive moisture that supports them. It may, perhaps, neutralise acids too, when they exist under certain combinations in these soils, more readily when applied in its comminuted or pulverised state, than in the lumpy one in which it is commonly used.

The proportion in which this substance is to be applied to the ground must depend, in a great measure, upon the state of the soil, the nature of the crop, and the purpose for which it is employed. In many of the southern counties it is laid on the stiff clayey soils in large quantities, as from twelve to fourteen or fifteen waggon loads, of from fifteen to twenty hundred weight each, to the acre; and on the sandy soils in some parts of Kent, at the rate of one hundred and sixty bushels to the acre.

On the deep and stronger kinds of soil, the practice is commonly

either to lay it on the clover leys while feeding off, or upon the summer fallows. And in the form of compost it is frequently used on the light soils, both to the fallows for wheat and the grass-lands.

As chalk cannot, by any means, be reduced to that state of powdery fineness that is the case with lime, and consequently cannot be so equally spread out, or so minutely blended with the soil, it is evident that much larger proportions of it must be employed to produce the same effects on the soil; perhaps seldom less than three or four times the quantity will be required.

Where chalk must be carried from a great distance in its wet heavy state, it will generally be the most œconomical practice to have it first converted into lime.

Marle is a calcareous substance, found under very different forms and in different places, and made use of as a manure with much advantage, both on the thin light soils and such as are more heavy and compact. It is distinguished, from its particular appearances, into *shelly*, *clay*, and *stone* marle. The first is evidently of animal origin, from its being composed of testaceous or shelly matters, in greater or less degrees of attenuation, from the gradual decomposition which they have undergone during the succession of ages, with a small portion of earthy substances mixed and blended with them. It is constantly found in such situations as have been covered with water, from which, as the sediments or depositions of mud or other earthy materials, in such cases, must have been different from various causes, such marles must be more or less pure, or contain greater or less proportions of calcareous matter, according to such circumstances; in general, however, they contain a larger proportion than the ordinary sorts of lime.

In the second kind there is much clay usually combined with the calcareous matter, from which circumstance it absorbs and retains moisture more strongly than most of the other kinds. The clayey sorts of marle vary greatly in respect to their colours, being met with both of a brown, blue, red, and yellow tinge; and the stone-marle has different proportions of sand united with the calcareous matter and the clay, upon which depends the differences in regard to its hardness. Where this sort of marle has a thin laminated structure and flaky appearance, it is frequently denominated *slate-marle*. From the portion of clay that is contained in these marles, they become capable of being gradually softened by the action of water, and ultimately fall down into the powdery state. All marles contain some portion or other of clay in combination with the calcareous matter, as has been long since shown, while in lime it is mostly sand which is united with that substance.

But notwithstanding these differences in the appearance and constitution of marles, they all agree in being reduced into a pulverulent or powdery state, by exposure for some length of time to the influence of the atmosphere, by which means they are rendered ultimately capable of being intimately blended with the different materials of the soils upon which they are applied: but as this general property of falling down into small particles, in consequence of the absorption of moisture and carbonic acid, or fixed air, from the

surrounding atmosphere, is much greater in some kinds of marle than others, it may cause some difference in their utility as manures. Where substances of this kind are laid upon land for the purpose of supporting an immediate crop of either corn or grass, there can be little doubt but that the most crumbly, or those the most readily reducible into a powdery state, are the most proper; but where they are laid on with the intention only of assisting future crops, or of producing more lasting effects, those that are more hard, and less disposed to fall into pieces, may be more advantageously employed. The former seems to be shown to be the case by the common observation of practical husbandmen in marling districts, that marle does not exert its full effects on the soil until it has been well mixed and incorporated with it by frequent aration, and by the practice of letting it remain some time on the surface of the ground before it is turned down, from which it becomes much pulverised and reduced; and the latter, by the circumstance of the harder sorts of marle remaining a great length of time upon, or within the ground, before they are fully decomposed or broken down.

This kind of manure produces beneficial effects on most sorts of soil in its different forms; the shell, stone, and those kinds of marle which abound most with calcareous earth, or which have sand in their composition, are the most adapted to the strong, stiff, clayey soils, as by the insinuation of such matters they are not only rendered more light and friable, but a great part of the injurious moisture which they contain is removed. But those in which clay is considerably predominant are found more advantageous in the light, dry, sandy, gravelly, and loamy soils, as by such substances the defects of lightness are remedied, and the necessary moisture in some measure preserved. On the stronger sorts of loamy soil, clayey marle will mostly be improper, as it has much tendency to render such sorts of land more wet and adhesive, by which they may be greatly injured. These have been found to be the effects resulting from the application of it even upon a temperate loam, in some parts of Sussex. And besides, it is sometimes apt to bring up coltsfoot, a weed which is difficult to be eradicated.

In the quantity or proportion of these substances that is applied, there is considerable difference in different districts, a circumstance which in some degree depends upon the nature of the soils; the heavy clayey or loamy requiring, in general, a much larger proportion than the light sandy or gravelly. The general quantity employed may probably be estimated at from about two to four or five cubic roods, of sixty-four yards in the statute acre, according to the state of the marle and particular nature and condition of the grounds on which it is laid. It may, however, in many cases be the most advisable practice not to apply too thick a covering at one time, but to have recourse to light dressings more frequently, as by such a method the fertility of the land may be better preserved and kept up, and the crops be rendered more abundant.

This manure is employed both on lands in a course of tillage, and grass-lands from different seed crops. On the former it is generally made use of as a preparation for barley, turnips, and other similar

crops, or applied upon clover or other new leys previous to their being ploughed up for wheat; in which modes of making use of it, the common practice is to leave it spread out upon the surface for some length of time before it is turned in, in order that it may be well reduced into a powdery form; for the more perfectly the marle is broken down and spread out, the more effectual it is found in promoting the growth of the crops. In its application in the latter case, it is frequently laid on in too large quantities, or left too long in its lumpy state; from both which circumstances disadvantages are produced to the growth of the grass, when either to be cut for hay or fed off by cattle; as by the former, where the marle contains much of the argillaceous material, a kind of crust is formed that prevents its springing, as happens where the stiff mud of ponds, and such-like manures, are too thickly laid on lands; and from the latter, the grass is not only injured by the small clods, as is experienced where imperfectly reduced clayey earth is applied, but the effects of the manure are prevented from being fully exerted, on account of its not being well broken, and carried down to the absorbent roots of the grasses, by the frequent rains that may take place after its application.

Some further attention seems likewise requisite in the use of this manure, as well as to the mode of cropping with it. When employed in large proportions, whether upon the heavier or lighter sorts of land, a considerable space of time appears, from experience, to be required to elapse, before it can with advantage be had recourse to again; for if this circumstance be not properly attended to, or too many white crops be successively taken, a very great degree of exhaustion is soon produced, as has been experienced in many of the marling counties of England, and in Forfarshire in Scotland. These injurious consequences are, however, found to be easily prevented, by adopting the alternating system of corn and grass or other green crops. And it is probable that by taking corn and grass crops in succession, or, after having one or two grain crops, letting the land be laid down for two or three years with artificial grasses, the application of marle in small quantities might be more frequently renewed, to the great advantage of the farmer and the improvement of the land. In some of the places where this kind of manure is made use of, as in Lancashire, something of this practice is adopted with much benefit. And when mixed with dung and other substances, in the form of compost, it is generally found capable of being repeated at short intervals with the most beneficial effects. From these facts it would therefore seem probable that such injuries are rather to be ascribed to the mode of cropping than to the nature of the manure. Something may also, perhaps, depend on the manner in which it is applied, as it has been found to be more efficacious when well mixed and incorporated with the soil, than where this has not been the case; and as it has been found highly advantageous in promoting and bettering the condition of the grass lands in some districts, while in others it has been objected to as injuring them, it is still further probable that much

depends on the manner and state of its being put in or upon lands, and that it is only where it is laid on in a moderate suitable proportion, and after it has been well broken down and reduced into a fine powdery form, so as that it may be very minutely and intimately blended with the soil, that its best effects can be exerted.

The circumstance of this substance having been used with great success in small proportions, as eight or ten bushels to the statute acre, after being burned in proper kilns, ovens, or other places, and well reduced into a fine powdery state, so as to be sown with the hand over the crops, as a top dressing, appears also to favour the same conclusion.

And the general practice of digging it up in the summer months, and spreading it over the ground in a lumpy state, in order that it may be acted upon and reduced by the heat of the sun and the frosts during the succeeding winter, is likewise in proof of the same thing.

This kind of manure is frequently procured by loosening and undermining large masses, and letting them fall down by forcing piles in above them; but great care should be taken in performing the business, as there is often much danger by the lumps giving way suddenly. In fixing upon places for opening pits, attention should be had to the injuring of as little land as possible, to having them as convenient as possible for carriage, to their having the least difficulty of draught, and to the water that may stagnate in them early in the spring producing the least possible mischief afterwards. Such pits should, indeed, only be made as can be easily laid dry.

The expense attending the use of this substance as a manure must vary considerably, according to the proportions in which it is applied, the facility with which it is dug from the pit, and the distance which it is carried. In this way it may vary from two to six or seven, and in some cases twelve or fifteen, pounds the statute acre.

In situations where both this manure and lime can be procured, the choice should be regulated by the facility and cheapness of obtaining one in preference to the other, the states of purity in which they present themselves, and the nature of the soils to which they are to be applied. Marle, where it contains much clay, may be preferable for a light sort of soil; while lime, as containing a larger portion of calcareous matter, may be more advantageous in some clayey stiff soils.

The shelly sand brought up and deposited in beds, in the crevices and level parts of the sea costs, is another substance capable of being employed with great benefit as a manure, not only on account of its containing calcareous matter in a fine attenuated state, from the rubbing down of shells and other substances of the same kind, but from the mixture of different animal and vegetable recrements with it, and a small portion of muriate of soda or sea-salt being retained. The last, from its known property of promoting the putrefaction and decay of animal and vegetable matters, when in such quantities, as well as that of destroying different kinds of

living insects, may contribute greatly to the good effects produced by it. This, indeed, appears still more probable, from that which is taken from underneath the water, or from such banks and places as are daily covered by the tides, being the most efficacious.

The proportion of calcareous matter contained in such substances must vary much according to the particular circumstances of the cases, which can only be fully ascertained by such processes as those which have been proposed for lime. Where the quantity of calcareous matter is large, and in a very reduced or attenuated state, it is by much the most valuable; as when there is much sand amongst it a much larger quantity will be required, and the expense of application be of course much increased.

This substance seems more proper for the clayey or loamy soils than those of the lighter kinds, especially where the proportion of calcareous ingredient is large. When equally spread, and well incorporated with such lands, it is generally found to produce good effects for a great length of time.

It has been observed that a considerably less quantity of calcareous matter, when in this fine state, will have a more sensible effect than when it is in that of any kind of earthy marle; as it admits of being spread over the ground with greater equality, and of being more minutely and intimately blended with the soil.

The quantity employed must obviously be different according to the circumstances and nature of the soil, as well as the sand; but twenty tons to the acre is, for the most part, considered as a proper dressing. It is frequently applied on the summer-fallows for wheat, and sometimes as a preparation for barley; it may likewise be laid on the clover, or other leys, before they are turned down for grain crops; but in these cases so large a quantity is not necessary. When put upon grass-land, in not too large a proportion, it commonly produces great and sudden effects, the crops quickly becoming very luxuriant. It is also observed, that such lands as have been treated in this way, when again brought into tillage, mostly produce abundant grain crops.

The effects of this sort of manure on the west coasts of the northern parts of the island have been very extraordinary, especially upon the heathy or mossy soils; and it is supposed that such kinds of sand are more common on the east coasts than has been generally supposed.

A shelly kind of sand, which in digging up appears with blue veins, has lately been used in some parts of Lancashire as a substitute for marle with considerable success.

Common sand can scarcely be considered as a manure; but it is frequently found serviceable in the stiff, clayey, and loamy soils, in lessening their tenacity, and rendering them more friable and mellow. It has been laid upon rough pasture and meadow land, in large quantities, with excellent effects, rendering the surface more equal, and bringing up a close thick crop of grass with much white clover. The quantity must be proportioned to the stiffness of the soils; it is, however, probably better not to apply too much at one dressing.

Manures from the Agency and Decomposition of Saline Substances.—Substances that contain much saline matter in combination with their earthy and other ingredients, are found, in many instances, when properly employed as manures, to contribute greatly to the support of vegetation. The materials principally made use of in this way are the refuse of different manufactories, such as bleaching and soap-boiling, where they can be procured in sufficient quantities, as in the vicinity of large towns, and where such manufactories are carried on in an extensive manner; the ashes remaining after the combustion or burning of various green vegetable matters, wood, pit-coal, peat, &c.; and some other substances, such as soot and sea-salt.

It is most probably to the different alkaline principles contained in these substances, from the great facility and power which they possess of acting upon and dissolving the parts of animal and vegetable matters, especially such of the latter kind as have been rendered insoluble by the absorption of the oxygen, or pure air of the atmosphere, from long or frequent exposure to it, and even fossil coal under similar circumstances, and by this means forming new saline compounds which are soluble, that their beneficial effects as manures are chiefly to be ascribed. The same author also remarks, that as such inert or insoluble vegetable or peaty matters, when decomposed or reduced into a state of solubility by alkaline substances, assume a brownish-red colour, and become insipid; the alkalies, in such cases, must enter into combination, and be neutralised by the acid or acids contained in them, which will be found to be the phosphoric and the oxalic, or acid of sorrel; from which will be formed, according to the nature of the alkali contained in the substance made use of, phosphates and oxalates of pot-ash, soda, or ammonia, which are matters capable of promoting the growth of plants.

But these substances, besides their forming in the soils, or the earthy materials with which they are mixed, such compounds as are beneficial in promoting the growth of vegetables, may be useful in many cases, when properly applied and used in sufficient quantity, in correcting acidity, in altering the state or condition of the lands, as, by the taking away of moisture from the surface where it prevails in an over proportion in meadows and pastures, they thereby support crops of coarse vegetables, and, by rendering the texture of such grounds as are under the plough more open and friable, consequently make them more suitable for the reception of the roots of corn crops.

The refuse of bleachers contains vegetable and mineral alkali, in such proportions as render it incapable of being employed without being previously mixed with other materials; for which purpose, fresh mould or peat earth should be procured; and after having been well mixed and blended with it, in the quantity of about eight or ten parts of the earth to one of the refuse, a proportion of rotten dung suitable to the purpose for which the manure is intended may be added, by which means a good manure will be formed.

The waste of soapers is another substance that may be made use

of in the same way; but in this there is a considerable portion of lime mixed with the alkaline matter. The lees, or liquors, which are drawn off after the making of soap, as containing much alkaline saline matters, may likewise, where they can be procured in sufficient quantities, and at a reasonable rate, be made use of in the same manner.

All these substances, when combined with rich vegetable mould or peaty matters, and made use of as manure, are found to be the most advantageous and useful upon the stiff clayey and loamy soils; as in such sorts of land they probably not only contribute to the increase of the crops by furnishing such soluble matters as can be readily taken up by their absorbent roots, but, by lessening their stiffness and tenacity, render them more proper for their reception.

The quantity of these manures which is necessary, must, as in most other cases, be various, according to the particular circumstances of the land upon which they are applied, and the views of the farmer.

They are laid upon lands in the state of tillage, as well as those under grass: in the first case they are mostly either put on in the state of compost, at the rate of about ten loads the acre, just before the seed furrow is given, or sown upon the surface, and harrowed in with the grain; but in whichever way they may be applied, it will be requisite to have them spread as equally as possible, in order that they may produce their effects in the most extensive and perfect manner; and in the latter, though they may in some instances be used alone, it is probably a much better practice to have them mixed with such earthy substances as have been described, before they are applied to the swards, as by such a practice their effects as a manure may be rendered more complete and lasting. To grass lands they are frequently used to the amount of from one hundred to one hundred and fifty bushels. And most grass lands are improved by the application of such manures, but especially such as are wet and disposed to the production of coarse sour vegetables, such as rushes, wild sorrel, &c.

The ashes, or earthy saline matters, which remain after the combustion of different fresh vegetable products, are all of them beneficial when judiciously employed as manures; but as this means of producing manure is much too wasteful and uneconomical a practice to be adopted, except in particular instances, as where wood and other vegetable productions are very abundant, and, used commonly as fuel, or where they cannot be readily cleared away by other more advantageous methods, as ten or fifteen parts, and in some cases considerably more, of such materials are dissipated and lost during the process, they can but seldom be made use of in the way of dressings for land. Where they can be procured in sufficient quantities for these purposes, they may, probably, be employed to the greatest advantage by being mixed with a good portion of rich vegetable mould, or peat earth, and a quantity of well fermented dung; as in such a compound state they are capable of being applied more extensively, and at the same time in the most favourable condition for the support of vegetation. When

made use of on the heavy soils, the quantity of ashes in the compost should be much greater than on those of the lighter kinds; they are, in general, the most effectual when applied as a top dressing to grass lands, especially such as are commonly termed sour, or have much tendency to the production of moss.

Peat-earth is a substance met with in many districts, and which, after being cut and exsiccated by the heat of the summer, is made use of as fuel in such places. By the consumption of peat in this way, a very considerable loss, so far as manure is concerned, is however sustained; as, in many cases, nineteen parts out of twenty of the material is dissipated and carried away in the process of combustion, which, as it has been shown that the inert vegetable or peaty matter produced by the action of, oxygen, or the pure air of the atmosphere, for a great length of time, is capable of being rendered soluble, by mixing lime in certain conditions with it, and still more effectually by alkaline saline substances, might have been preserved and rendered useful as manure. In some places, however, as in Berkshire, it is the common practice to dig up peat-earth, merely for the purpose of burning it into ashes, in order that it may be used as a manure.

As fresh or green vegetable productions are only capable of yielding alkaline saline substances when burned, none being afforded by the combustion of dead or decayed vegetable matters, it seems probable that the ashes of peat-earth seldom contain much saline matters. It is, however, observed by some writers, that all peat-earths afford alkaline saline matters in a greater or less proportion when burned, and that in some it is from a twenty-second to a thirty-second part of their weight. The ashes produced from the burning of peat about Reading, in Berkshire, which long experience has shown to possess great fertilizing powers, are asserted to contain no alkaline salts, nor, from the hasty analysis of them which was made by the writer, any saline matter, except a small proportion of sulphate of magnesia, or Epsom salt. But it is added, that if the analysis had been more carefully made, and when the ashes were newly burnt, they would most probably have been found to contain a hepar of lime, which is a saline substance soluble in water, while gypsum, the substance to which it returns on being exposed to the air, is insoluble. The fertilizing effects of these ashes may, therefore, probably materially depend upon this hepar of lime. This is rendered still more probable from the observation, that "the hills on each side of the meadows which produce the Newbury *peat-ashes* consist of calk, easily dissoluble by heavy rain, which washes it off the ridges down the furrows, ditches, and streamlets, to the low grounds, where mixing with the floods, it is floated over the meadows, and deposited in the peat; consequently that the peat of this district differs from that of most others, by the quantity of chalk which it contains; and, when dug, dried and burnt, the fires reduces the chalk to lime, and the rest to ashes. Hence Newbury ashes are a mixture of lime and vegetable ashes; and it is very probable that any common peat-ashes, or the ashes of rough grass land, of turf, heath, furze, ling, wood, &c. pro-

duced by the operation of paring and burning, being mixed with chalk lime in due proportion, would be as equally fertilizing as these noted ashes."

Peat-ashes may be used as a manure, either by being harrowed in with the grain, or sown as a top dressing after the crops have come up; in the former case they should be employed in a somewhat larger proportion than the latter. In the latter method of using them, the best practice is to sow them over the crops before they are grown too high; and if the weather be rather inclined to wetness, it will be the more favourable: the quantities commonly employed in these cases are from fifteen to twenty bushels the acre, according to the state or condition of the land. When laid on grass lands, whether those of the artificial or natural pasture kinds, these ashes frequently effect great improvements, rendering the grasses both thicker and finer.

The ashes of pit-coal, where they can be procured in sufficient quantities, as in large towns where it is principally employed as fuel, are, when applied as manures, found to be useful in many respects; but as these can contain saline matter only in proportion to the quantity of fresh vegetable products that may have been consumed along with them, little of the effect which is produced by them can depend upon it; much more, probably, arises from the portion of calcareous earth which they contain. Something too, in many cases, probably depends on the animal substances that may have been occasionally burnt, or afterwards mixed with them, before they are made use of as a manure. They may also be serviceable on the stiffer sorts of soil, by rendering them more open and disposed to admit the roots of growing vegetables. That they may be beneficial in these ways seems to be shown by their utility in the stiff clayey grounds from which brick-earth has been dug, and on what are generally termed sour lands. On the more tenacious loamy soils they may operate by giving friability, and at the same time the calcareous principle, in a small degree, when it is sufficient. This is a conclusion which is further supported by their having been found from experience to be much less useful in the poorer sorts of land.

By the application of these ashes, in the vicinity of London, to the stiff soil from which the brick-earth has been taken, they render it sufficiently friable to afford a good crop of beans, a vegetable which, though it grows well on the heavy soils, could not otherwise be produced on lands so very stiff as the bottoms of brick grounds generally are found to be. After this crop has been taken, it is usually remarked that such grounds are in a condition to admit of grass seeds being sown with the succeeding crops. But except in such cases as the above, this manure is probably the best adapted to grass lands as a top dressing; it may, however, occasionally be used in this way to the young grain crops. The proportion which is necessary must be different according to the intention of the farmer, the nature of the crop, and the state of the land.

Soot is another substance that experience has shown to be of considerable utility, where it can be collected in sufficient quantities

and applied to land as a manure. The beneficial consequences resulting from the use of this substance depend, probably, in a great degree, on the quantity of alkaline saline matter which it contains; which, by its action on the rich vegetable mould of the soil or earth with which it is mixed, may render it more capable of supplying the nutrition of plants; and it may bring the thick oleaginous matter of the soot into such a state as to be capable of solution or diffusion in water, and thereby in a condition to be taken up by the absorbent roots of vegetables. The earthy matter of this substance, as well as that of different kinds of ashes, may probably be rendered more suitable for the purpose of promoting vegetation, by their having been exposed to the action of fire, as is well known to be the case with clay. The great state of tenuity or fineness in which soot is found may, likewise, be serviceable, as by that means it becomes capable of being more regularly and more extensively mixed with the soils on which it is applied. Indeed the good effects of most substances employed as top dressings depend, in some measure, upon this circumstance.

Soot, as it contains alkaline salt in a considerable proportion, might probably be used with greater advantage by being well mixed or blended with rich mould, or peat-earth, and by such a method the quantity of manure would be greatly increased. This should not, however, be attempted where the destruction of insects forms any part of the design of the farmer.

This manure is chiefly made use of as a top dressing to grain crops and grass lands. On the former it has been found extremely useful in destroying the wire-worm and other destructive insects. This is probably effected by the bitter oleaginous liquid formed from the union of the alkali and the oil of the soot, impregnating those parts of the plants on which they feed, and thereby causing them to be rejected by such insects. It may also produce some advantage in this respect by promoting a rapid vegetation, and thereby rendering the texture of the plants, very quickly, too firm to be preyed upon by them. That soot is very powerful in promoting the vigorous growth of vegetable crops, is evinced by the change which takes place after sowing it over such young wheat-crops as have a yellowish sickly appearance, as they frequently put on, in a very short time afterwards, the healthy green aspect. On meadow and pasture lands experience has likewise shown it to be highly useful, not only by encouraging the growth of a finer sort of grass, but by destroying or correcting the frequent disposition of such grounds to produce moss, and some other coarse sorts of vegetable productions. The proportion of this, like that of all other manures, must vary according to the circumstances of the case. The common quantity is generally from about forty to fifty bushels on the acre.

Where ashes, soot, or any other material that contains saline matter, are to be employed as manures, they should always be preserved in sheds, or other convenient places, from rains, or the accidental application of water to them, as where this practice is neglected the saline substances are soon dissolved and carried away

in a liquid form. It is chiefly from this cause that substances of this kind which have been long exposed without being covered, are often found so inferior in their effects to those which are fresh or newly made. On this account also, if such substances are laid on land at too early a period of the season, they will be liable to have much of their valuable properties carried away by the rains that may take place.

Muriate of soda, or sea-salt, is a substance, the utility of which, for the purposes of manure, seems not yet well ascertained, as by some writers it is considered as possessing considerable powers of promoting vegetation, while others have experienced little or no advantage from its application; but the experiments of Pringle and Macbride show, that though it may prevent putrefaction when employed in large proportions by its antiseptic property, yet, when used in small quantities, it has evidently a tendency to promote the process. On this account it may therefore be serviceable when incorporated with farm-yard dung, and other animal or vegetable matters, in small portions.

This substance may likewise be useful in other ways, as, from its known power of destroying various kinds of insects, such as worms, slugs, grubs, snails, &c., a power which an able writer supposes to depend on the exciting of greater evacuations from their bodies than they are capable of withstanding, much nutrient matter may, in different cases, be provided for the support of vegetation.

As every-where in the vicinity of the sea a ready means of obtaining this saline material in unlimited quantities offers itself, it may deserve more particularly the notice of the agriculturist: and more especially as many other substances that are known to contain or be impregnated with it, such as the weed thrown up by the tides, and the sand over which they flow, can be easily procured.

Common salt has lately been subjected to a series of interesting experiments by the Rev. Mr. Cartwright, which are detailed in the Communications to the Board, and which in some measure set its utility as a manure in a more clear point of view. In order, however, to render its effects as a manure fully satisfactory, and of the most practical advantage to the farmer, experiments of this sort should be made on different kinds of soils, with different sorts of crops.

The bittern, waste, or refuse, of salt-works, which generally contains muriate of magnesia in large proportions, is found to possess very great septic qualities, and may therefore be highly useful when mixed with dung, or earthy matters. The experiments that have been made with this substance likewise show it to be capable of promoting vegetation in a considerable degree.

But in whatever way substances of the saline kind may produce their effects in promoting vegetation, when employed as manures, it is evident from their containing in themselves little or nothing of such matters as are capable of affording nourishment to plants, that they may, in most cases, be made use of to the greatest advantage by being mixed and incorporated with such substances as they are capable of acting upon and reducing to a state proper for the support of

vegetable crops; such as rich earthy materials, imperfectly reduced dung, and other matters of a similar kind. Where substances that contain the muriate of soda, or sea-salt, are employed, if the opinions which have been stated above be correct, they might probably be applied to much advantage by being mixed with imperfectly burnt clay, when reduced to the state of powder. And if, upon trial, they should be found effectual in this form, they might be very conveniently made use of in the way of top dressings to grass or grain crops in the spring.

Manures from the Combination of different Substances.—It is evident, from what has been already observed on the nature of the different substances that are capable of being made use of as manures, that they may frequently be mixed and blended with each other, or with substances of other kinds, and by such means be not only considerably increased in quantity, but in many cases rendered more effectual and more suitable for application than in their simple states; but at the same time, that some of them may be mixed and incorporated in this way with much more advantage than others: for though the general experience of farmers has fully shown the great importance and utility of employing compound manures, or composts, little attention has, till lately, been paid to the compounding or mixing together of such substances as are, from the principles which they originally contain, or which are formed from them in the changes which they undergo in the different stages of their decomposition, adapted to act in the most suitable manner for producing such combinations or alterations in the materials, as are capable of being beneficial in the promotion of vegetation when they are employed as manures.

Farm-yard manure, which is the most general application of any, from its being formed by the decay of various kinds of vegetable matters, such as hay, straw, fern, and many other materials of a similar nature, with which the dung and urine of animals are incorporated and combined, must be considered as a compound substance. And from the large proportion in which such vegetable productions enter into its composition, and the quantity of earthy materials that is in most cases, especially where the management is upon a judicious plan, added by the laying of suitable bottoms, it is not so frequently necessary to be blended with other substances that are usually employed in forming composts. But from most of the vegetable materials that constitute the chief part of this sort of manure, being made use of in a dry and hard state, they do not so quickly ferment or run into the state of decay, notwithstanding the proportion of animalized matters that may be mixed with them; it therefore becomes an useful practice to turn them over, by which their complete putrefaction may not only be promoted, but the different materials be more minutely blended together; on both which accounts they may become more useful when applied as manure upon land. In the forming of this manure, care should also be constantly taken that the heaps be so situated as that they may not become too dry, or too much soaked in water, as in either case they must be greatly injured. Whenever it may be requisite to incorporate any

earthy material with this sort of manure, the agriculturist should always carefully attend to the state or richness in which it may exist in the yard, and proportion such additions accordingly. It will, however, never demand nearly so large a proportion, as such manures as consist almost wholly of animal matters.

Where animal matters are collected and thrown together in any quantity, there can be little doubt but that a great increase of good manure may be provided by mixing with them, as has been already observed, rich surface-mould, peat-earth, or the scrapings of old ditches and roads; as by such a practice the ammonia formed during the decomposition of the animal substances is prevented from escaping, as would otherwise be the case, which by combining with and acting upon the earthy materials, quickly renders them proper for the purposes of manure. As substances of the animal kind have been shown to run very rapidly into the state of putrefaction, they may frequently be incorporated with such vegetable materials as are little disposed, or with difficulty made, to rot or become putrid, and by such means useful composts be more expeditiously formed. In making use of such earthy substances as have been mentioned, it may be of much advantage to have them exposed to the influence of the atmosphere for a considerable length of time, frequently turning them over, before they are mixed with the manures, as by such means they become in a more pulverized state, and are capable of being more intimately blended with such materials, and afterwards spread over the land with much greater equality; a circumstance upon which their effects very much depend. If, in performing this business, the earthy substances be formed into a sort of ridge, about five or six feet in height, and nearly the same breadth in the bottom, they will be in the most proper situation for being united with dung, or other matters that may be employed.

From the experiments of a late practical writer it would seem, that such earthy materials as have been mentioned may be made use of to a very considerable extent, especially where the manure to be mixed with them is of the animal kind.

Lime is a substance that has often been too indiscriminately made use of in the formation of composts, but which, by attending to the following circumstances, may admit of being employed extensively and with more beneficial effects. Where the destruction or decay of green or fresh vegetable matters, especially those of the more coarse and hard kinds, is intended, it should be used in its caustic state in small quantities; as in this condition, thus sparingly employed, it reduces more expeditiously the ligneous and more hard parts of such matters to an earthy state; and as, during its action in this way on these substances, such elastic matters are set at liberty, as by their subsequent combination afford ammonia or volatile alkali, it may frequently be a beneficial practice to blend such earthy substances as have been just mentioned with them, and thereby prevent the elastic matters from being dissipated and lost. If a portion of rich farm-yard dung be afterwards incorporated with these materials, a valuable compost will be formed

Quick-lime is likewise found useful sometimes in bringing the

hard parts of the dead vegetable matters, as tanners' bark, fern, straw, cabbage-stalks, leaves, &c. quickly into the state of earth or mould; but whenever it is made use of in this way, it should be had recourse to only in a very scanty proportion to those of the matters with which it is mixed, as, when it is employed in large proportions, it is liable (from the heat that is extricated or disengaged by its combining with the moisture of such substance, being greatly augmented during its slaking,) to convert them into a coaly substance that is insoluble, and at the same time to force off, in the form of gas, their elastic principles, except such a quantity of carbonic acid as may combine with the lime during the process.

By the common practice of blending quick or caustic lime with farm-yard dung, much loss is frequently sustained; as, by its violent operation upon such substances, some of the elastic matters are not only set at liberty and quickly conveyed into the atmosphere, but, with what remains, insoluble saline compounds are formed which cannot assist vegetation.

The complete putrefaction of such manures, when necessary, is probably the best promoted by the use of lime in its mild state, and the various means which have been already described.

When lime is to be blended with peat or earth, the most advantageous method is to use such lime as has been newly made and well slaked, in the proportion of about one part of the lime to five or six parts of the peat or mould, which should not be too much exsiccated, or dried, before it be made use of. By this means the heat which is generated will not be sufficient to produce any injurious consequences, either by forming a coaly matter, or forcing off the elastic principles in the state of gas. And the volatile alkali which is composed in such cases, by being allowed to enter into combination, as it is formed, with that part of the peat or mould which has not been acted upon by the lime, in consequence of its being employed in so small a proportion, and in its effete state, will form a soluble saline substance, capable of promoting vegetation.

There are other substances that may be still more beneficially employed in forming composts with peat earths, when they can be procured in such quantities and at such cheap rates as render them capable of being made use of in this way. These are alkaline saline matters, or such substances as contain them in any quantities; as, by mixing these with the peaty materials in the way mentioned above, they are made perfectly soluble; while by the use of lime, only such a proportion of them is rendered soluble as can be acted upon by the quantity of ammonia or volatile alkali formed during the time it is mixed with them. And, further, insoluble compounds, such as have been just noticed, are formed in the latter case.

It is common, in many districts, to make composts with lime and mould on the head lands, or other parts of the fields on which they are to be applied. This cannot however be done to any great advantage, except where the surface mould is rich in vegetable matter; but wherever such composts are to be formed, the grounds should be ploughed or dug up to a considerable depth, and reduced into as perfect a state of pulverization as possible; fresh lime may then be

placed, in small heaps, all along the middle of the ridge or head-land, and the earth in this fine state be thrown over them, in the proportion of four parts of earth to one of lime, and kept close by being beaten down with the spade; from the gradual slaking of the lime, in this situation, by the moisture of the earth, elastic matters are set at liberty, which, combining with the mould or earth, render it still further reduced; and by being afterwards very intimately blended, by means of the spade, with the very fine particles of the lime caused by the slaking, a valuable compost is made for the stiffer sorts of soil, especially if a small quantity of good rotten dung be incorporated with them.

The animalized and other matters contained in farm-yard dung, or compost, from their being, in that state, for the most part mixed and blended with large quantities of earthy materials, produced by the decaying or rotting of vegetable and other substances, and the depositing of soil or mould underneath them, as has been observed above, are seldom capable of admitting any further additions with advantage. But wherever there is much liquid matter oozing from such composts, or stagnating about the bottoms of them, some of the earthy matters which have been mentioned should be laid round it in order to absorb or take it up, and prevent the great waste that must otherwise take place, as may be often observed where dung composts are made in fields, the sides of roads, or on other waste grounds. This should be more particularly attended to where such composts are laid in situations that have not been properly formed as dung-steads; and in such cases, it may frequently be an useful practice to place a considerable thickness of such materials in the bottoms, before the farm-yard compost is carted out, and laid upon them, as by that means the manure heap may be greatly increased, at the same time that a proper substance for the volatile alkali contained in such liquors to act upon, is supplied. The utility and advantages of this method of proceeding are fully confirmed by its becoming the prevailing practice wherever there is any attention paid to œconomy in the forming of compost manures.

There are many circumstances, such as the nature and state or condition of the land, the goodness of the manures, the distance they are to be carried, and the expense of procuring them, which render a difference in the quantity of such compound manures necessary, and which can only be properly judged of by the persons who have the application of them: on the heavier kinds of land, such as those of a clayey or deep loamy nature, such composts as are constituted of the lighter sorts of earthy materials should always be employed; while, on the thinner and more light sorts of soil, those which are formed of clayey, loamy, or the more tenacious earthy matters will be found most suitable. In general, the allowance of such manures should be from sixteen to twenty loads to the statute acre, each containing seventeen or eighteen hundred weight. On many occasions, however, a much larger proportion may be required, and in others a less may answer the intentions of the farmer.

The mixture of dung, litter, and other materials, which is gradually collected and formed into heaps in the farm-yard, is, in general, when

employed without having any other substances incorporated with it, laid on such lands as are under preparation for wheat, turnip, or barley crops. It is likewise in some places laid on for a pea crop, where wheat is intended to be the succeeding crop.

The composts or manures, collected from the streets of large towns, are commonly formed of a great variety of substances, as the recrements of decayed vegetables, putrid animal matters, and ashes; but from their abounding, for the most part, with substances of the latter kinds, they may, on the principles we have so often stated, be in many instances greatly increased by having rich surface mould, or peat earth, blended with them; and by such a practice, where the manure heaps are in a condition to admit of it, the risk of waste, by the escape or dissipation of their more fluid contents in the aërial or gaseous state, may be effectually guarded against.

Such additions can, however, be advantageously made, only where the proportion of animalized materials in the manure is considerable; in other cases it will be better to employ them in the state in which they are formed and collected.

This sort of manure is capable of being made use of with great benefit on most soils, and in preparation for different sorts of grain crops, as well as those of grass. When applied in the proportion of fifteen or twenty tons to the acre, it generally produces great fertility; it should, however, like all other manures, be laid on according to the particular circumstances of the soils, and the nature of the crops for which it is employed.

The trials of practical agricultors fully show, that the most advantageous composts are those which are formed by the combination of earthy materials with animal matters. In this way ground bones and whale blubber have been found highly useful; but the effects of the former are asserted to be the most powerful when applied on the moister sorts of soil.

From the whole of what has been advanced above, it is therefore probable, that by proper attention to the mixing together of such substances as are adapted to act upon each other, and suited to the state of the soil, manures may be increased, and rendered much more serviceable, in promoting the growth of crops and augmenting the fertility of land, than they have hitherto generally been.

MEANS OF AUGMENTING AND PRESERVING MANURES.—On due attention being paid to the increase of manures, and the modes of preserving and managing them, in a great measure depends the general fertility of farms, and the luxuriance or goodness of the crops that are grown upon them. It is therefore a matter of great interest and importance for the farmer to see that nothing is wasted or thrown away, that can possibly be converted to such a purpose. That there are many substances that may be rendered useful in this way, which have hitherto been little regarded by the cultivators of land, there can be little doubt, when the daily waste of animal, vegetable, and other matters, that takes place in every country, from their being carried away by rivers, or consumed by fires, is fully considered.

Another great cause of loss in the production of manures is from the want of adopting or putting in practice such modes of manage-

ment, in respect to the different substances, as are capable of rendering them fit for the purpose of application in the most quick and expeditious manner; for it is obvious, that if by properly attending to such means the same quantity of manure can be prepared in a short space of time, which under other circumstances must have required a long one, much increase of manure may be effected, and consequently great advantage be gained by the cultivators of the ground.

As the principle resource, on most farms, for the production of manure, is the farm yard, it should be constructed in such a manner as that every thing may with ease and facility be converted to the purpose. In general one dung-stead may be sufficient; but where the size of the farm is large, two or more may be necessary, as the putrefaction of such heaps proceeds with greater regularity and expedition, from the excess of air and moisture being more free, when they are not made too large; and, besides, they can be more conveniently turned over or removed. The parts of the yard on which they are situated should, while they are convenient for depositing the dung, and other matters from the sheds and other offices, upon, be neither too much elevated, so as to cause the dung to become dry, nor so greatly depressed as to favour the stagnation of water upon it, and thereby deprive it of the properties most essential to the promotion of vegetation. Before each of the dung-steads a reservoir, or basin, ought to be made, into which not only the drainings from all the different sheds and places where animals are fed or kept, may empty themselves, but likewise the urine from the necessaries, the suds from the wash-houses, and the washings of the various utensils employed in the family. Without these advantages in the construction of farm-yards, much loss of manure must daily occur from the liquid matters of such places continually running away, and being otherwise wasted, as well as from their not being made use of to forward the conversion of other substances into the condition of manures.

Where these and such other suitable accommodations as have been already described are provided, the farmer will have little more to do than be careful in saving or providing such matters as are suitable for the purpose, and causing them to be properly placed and removed, in order to have them speedily reduced into the state of manure, and the quantity of his dung heaps thereby greatly increased *. In this view, various vegetable matters, such as hay, straw, fern, leaves, rushes, coarse grasses, flags, and many other aquatic plants, should be preserved and collected in as large quantities as possible; by allowing nothing of the kind to be sold or carried from farms, except in some particular instances, as where they are situated near large cities, or towns, where such articles can be advantageously disposed of for the purpose of feeding and littering horses, or other animals, and at the same time an equivalent in good manure be brought back to the farm; by mowing and raking together the wheat or other stubbles, the fern from the commons, and leaves where they can be obtained, as in the vicinity of parks and other woodlands, and by

* See the Section on Farm Buildings and Offices.

cutting the coarse grasses and aquatic vegetables at such periods as they are in the most juicy and succulent states. The whole, after being sufficiently dried, should be carried to the farm-yards, and stacked up in convenient situations, either in or near them, for the purpose of being made use of as litter. Besides these means, every leisure opportunity should be taken, before the commencement of the foddering season, to bring into the farm-yards such quantities of peat or boggy earth, rich surface mould, marle, dry mud from ponds or ditches, scrapings of roads, loam, and other substances of the same kind, as can be conveniently obtained.

Such materials as are necessary being by these methods procured, the best mode of proceeding seems to be that of covering the whole of the yards, where the cattle stand and tread, and even the pig-sties, in some cases, with layers of these earthy matters, eight, ten, or more, inches thick, according to the number of cattle, and other circumstances; and also to deposit in the reservoirs before the dung-steads, proper quantities of the same substances, for the liquid matters which come into them to act upon. Upon these earthy bottoms, at the time the cattle are confined, pretty thick litterings of one or more of the materials that have been collected and stacked up, may be placed, and the stables, cow and ox-stalls, pig-sties, &c. cleaned out upon them. Where it is the practice to tie up and confine the cattle in the night-time, the straw, or other substances, after having been broken down and reduced by littering them, may be used for covering the bottoms of the yards, by which means their decay may probably be rendered more quick and convenient. It appears also probable, that where stubble, fern, rushes, leaves, or other vegetable matters, the textures of which are hard and ligneous, are employed, their decay, or reduction into the state of manure, may be greatly expedited by means of a slight portion of lime, in its active state, being spread over the earthy bottoms before they are applied, as has been found to be the case with tanners' bark.

Where the matters made use of in the way of manures are liable to be rendered too dry by the weather, their putrefaction and decay may be much promoted, as we have already seen, by having them sprinkled over occasionally with water, which may be conveniently and readily performed by having a pump, with troughs, fixed properly for the purpose: or, where these are wanting, from a pond in the yard.

To render the plan the most effectual it is capable of, the whole of the cattle should be strictly confined to the fold or foddering yards, during the winter, and not turned out, as is frequently the case, into the pastures, by which the making of much manure is prevented, great injury, in many situations, done to the grass-lands, and the stock, from being much exposed to cold and other causes, benefited in a far less degree than is commonly imagined. By pursuing this method, from the great consumption of straw and the coarser sorts of food, by the young lean cattle, and of hay and luxuriant vegetable roots or plants by the others, such quantities of animalized matters are voided, as, by mixing with the bottoms of the yards, hasten their putrefaction, and afford not only an immense increase of manure, but of such

as is of a very valuable kind. If there be not a sufficient proportion of animal dung and urine incorporated with the other matters, which can seldom be the case where the cattle are not regularly confined to the fold-yards, the manure, though it may be nearly as large in quantity, is found by experience to be very inferior in its effects when applied to land.

Where the number of cattle confined in the fold-yards is great, it may be necessary, occasionally, to remove the bottoms, and the matters littered upon them, to the dung-steads, after they have become in some degree manures, by being well saturated and blended with the urine and other animalized matters. These must be immediately replaced by others in the way we have just noticed. The earthy substances from the reservoirs must also be occasionally emptied out upon the dung-heaps, and replaced by quantities of fresh materials of the same kinds, and the stems of different gross vegetable products from gardens or other places, when it can be done.

At the close of the season, when the cattle are turned out of the yards, the heaps of manure which have been thus collected and thrown together, are to be turned over, in order that the animalized matters may thereby not only be still more intimately incorporated with the earthy substances, but, likewise, that more of the pure air of the atmosphere may be retained among the clods, from their being rendered much smaller by such means, and the putrefactive process be thereby more perfectly produced. After this business has been well performed, as little delay as possible should be suffered to take place before the manure is applied to the soil; as from the combination of oxygen or pure air with the carbonaceous material of the dung, and of azote with hydrogen, under these circumstances, such fluid matters are formed as constitute its most beneficial properties, but which are afterwards continually wasting so long as it remains unapplied to the ground.

On these accounts, as well as those which have been already mentioned, manure heaps should not be made too large, but of such sizes only as that they can be expeditiously turned over and put upon the land. And another advantage which attends the having different heaps, and their not being large, is, that one can be prepared and carted away at a time, without the other's being in the least injured by any delay that may happen from unforeseen causes.

By the mixing of effete lime with manures composed of earth and dung, in the more advanced stages of their preparation, some increase of quantity may likewise be produced; and at the same time, as we have already seen, by its uniting with the nitrous acid during its formation, may prevent its being thrown off into the atmosphere in a gaseous form, or readily washed down from the composts by rains; and thereby preserve a substance that has long been found useful in promoting vegetation.

As a great waste of manure is continually taking place from the evaporation of the more liquid parts of such heaps, where they are much exposed to the action of the sun or winds, and the washings of the rains, it would no noubt tend greatly to the saving of such matters, and at the same time considerably promote their complete

putrefaction and decay, to have them placed in situations that are much shaded by trees or other means. In the farm-yards, it is probable that moveable coverings of some light kind of material might be highly advantageous for the same purposes.

Different modes have been pursued, in different places, in order to procure manure from the articles of food and other matters produced on the farm: by some it has been strenuously contended, that the most advantageous plan is to have the whole of the hay and straw consumed by the different animals, without employing any of them in the way of litter, floors or standings for them being constructed in such a manner, as that they can be tied up and kept clean and dry merely by sweeping, without being littered with straw or other similar materials; while others assure us, on the ground of actual experience, that the method of eating the hay by the stock, and employing the whole of the straw, as well as other matters, in the way of litter, as we have seen above, is by much the most effectual in promoting the increase of manure. But though each of these methods may be practised, with more or less advantage, according to the nature of the farms;—as where there is much grass and little tillage land, the former may be preferable: but where the quantity of grass is small, and that of arable ground large, the latter:—it is probable, that a judicious combination of both may be the most beneficial, especially where, in addition to the common articles, coarse vegetable and rich earthy matters are provided and made use of in the way which has been mentioned, as by such a combination only can the full effect be produced. In the former method, the loss by means of digestion and animalization is probably much greater than has been generally supposed by those who have maintained the superior utility of the practice.

The soiling of horses, and different kinds of cattle, with rich green food, as clover, summer-tares, and other artificial grasses, cut fresh every day during the summer season, and placed in cribs in the sheds or foddering yards, the bottoms or floorings of which have been prepared and strewed with earthy materials and litter, in the manner we have already seen, is a practice by which great additions may be made to the dunghills, as the evacuations of cattle fed in this way are very considerable.

By means of covered sheep-folds, a great increase might also be made annually to the stock of manure. If this neglected, but highly beneficial, practice was regularly employed here, as is the case in many other countries, by having proper sheds and inclosures for the purpose, constructed of any slight materials, near to the fold-yards, or other more convenient places of the farm, so that the sheep might have fresh air and sufficient liberty to run about, and at the same time have the means of being sheltered from rain, snow, and the coldness of the winter season, the advantages to the flock would likewise be considerable, besides the great supply of manure that must be provided. In order to promote the latter advantage, the bottoms of floorings of such sheds and inclosures should be covered with such earthy materials as have been recommended for the cattle yards, and also littered upon in the same manner; all of which ought to be removed and

cleared away to a heap, or the common dung-steads of the farm-yards, as often as they become perfectly saturated and blended with the dung and urine of the sheep, and fresh materials of the same kind supplied. In bad weather it will be advantageous to keep them constantly in these covered folds, and feed them with hay in standing racks; but when it is fine they may be suffered to go into the pastures in the day-time, and only be put into the folds during the night. The practice of keeping sheep in covered folds is made use of in Flanders for the purpose of raising manures with great success; and very dry sand is sometimes employed for the bottoms of the folds, instead of litter.

Where the house-lamb system is carried on to any extent, the preparing and littering of the sheds and yards, into which the ewes are occasionally put and the lambs kept and suckled, might be practised with great advantage in respect to the productions of manure, as animals under such kinds of management are constantly found to void urine and dung in much larger quantities than in the ordinary courses of feeding.

By feeding of different green crops on the land by sheep, or other animals, much fertility may occasionally likewise be given to the soil, at a cheap rate, as the expense of carriage is prevented, and a considerable saving of manure thereby effected. Mr. Middleton seems of opinion, that by this mode of management the great loss of urine and dung that unavoidably occurs in the other methods may be the most effectually prevented: "For," says he, "in the stables, cow-houses, sheds, fold-yards, and dung-hills, even under the best management, there is a great waste, perhaps of half, including dung and urine: under ordinary management three parts of this manure is lost; but in the soiling of tares, turnips, cole, clover, etc., in the fields, there is *no* loss; the whole is immediately applied without the cost of carriage, to the enriching of the soil." It is evident, however, that in this way there must be much more waste than is here supposed: by evaporation, from the action of the sun and wind over so extensive a surface, much of the valuable matters of manure, in such situations, must be daily carried away; and the more fibrous or ligneous parts of the materials, which are rejected as food by the cattle, from their being thinly scattered over a large space. becoming dry and hard, must be longer before they decay, or are rendered fit for the purposes of manure, than where they are collected together in larger quantities and in more confined situations.

Another means of increasing manures to a very great extent, is by adopting such methods as may effectually prevent the soil and urine of privies, and the various animal and vegetable materials that are continually thrown into them, in cities and large towns, from being uselessly retained in deep pits, or places constructed for the purpose, or inconsiderately washed away and wasted, by being conveyed into rivers or ponds by sewers and drains. It is stated, that, from want of suitable modes of preserving such substances, the annual loss, in this country, is probably not less than five millions of cart loads, which, if turned to the uses of agriculture, would be worth to the cultivators of the soil two millions and a half, and to the community

five millions of pounds sterling. The most easy and convenient methods of preserving substances of this kind in the country would be, probably, by having pits formed for the reception of them, as near as possible to the dung-steads in farm-yards or other places, and prepared with floors of clay, or some other material through which the liquid matters could not readily pass; these might be connected with the privies by proper drains, and have covers fitted to them, in order that a quantity of mould, peat-earth, saw-dust, lime, stems of coarse garden plants, or other substances of the same sort, might be occasionally placed in them, and removed to be blended with the common dung-heaps, as often as they became fully reduced by putrefaction, and well saturated and impregnated. But in large towns or cities, where such manures are produced in great quantities, reservoirs or basons of large sizes should be constructed, with floors of the above kind, and be connected with the privies of different parts by means of sewers or drains. Such reservoirs ought to be so situated as to be capable of being emptied with ease and facility, as often as necessary, by persons appointed for the purpose, and their contents carried away in the night-time. Where there is the convenience of rivers, however, as in London, and many other populous cities and towns, a large proportion of such manures might, in most cases, be readily emptied from basons of this sort, formed on their banks for the purpose, or perhaps from the extremities of the common sewers themselves, by means of proper sluices, into covered boats or barges, and be thus cheaply carried to a distance, for the advantage of agriculture; a method, in some respects, practised with success in Sweden. As this kind of manure is extremely liable, from the agitation of the carriage in which it is moved, to become so liquid as to be conveyed with great difficulty, it is probable that, by having such earthy or other substances as have been mentioned above, or as could be conveniently procured in such large cities or towns, (such as the long littery dung from livery stables, lime rubbish from the pulling down of old houses, and the fresh earth dug up in preparing the foundations for new ones.) mixed and blended with it in the pits or reservoirs, for some time before they are cleaned out, the difficulties attending the carriage of it might not only, in a great measure, be obviated, but the disagreeable smell issuing from it be much corrected, and the quantity of manure greatly augmented. By some method of this nature, under the management and direction of proper persons, vast stores of fertility might be provided in such places for the neighbouring districts, which inattention or popular prejudice at present withhold from the uses of agriculture.

In the vicinity of the sea, where shell and other small fishes can frequently be procured in large quantities, by having them well mixed and incorporated with good surface-mould, peat-earth, or other similar matters, a vast increase of good manure may also be produced. In such situations, too, the weeds cut from the sides of the rocks, or which are thrown up by the tides, when collected into heaps, and mixed with small proportions of lime and suitable quantities of mould or earth, may contribute greatly to the increase of the compost heaps on the farms.

The vegetable mould or other materials contained in the bottoms of ditches, and in boggy, hollow places, where water frequently stagnates, and largs crops of aquatic or other plants alternately vegetate and decay, may likewise be dug up and applied with benefit to soils for which they are proper, either in the state in which they are found, or after they have been formed into composts with dung, lime, or some other substance of a similar kind. Clay may also be employed with great advantage on sandy soils, and save other more valuable manures: it seems, however, to be the most serviceable for this purpose after it has been imperfectly burnt in clamps or kilns, probably from the proportion of oxygen or pure air that is thus combined with it, or with the metallic matters which it contains. In short, it is necessary, in order to increase the stock of manures on farms to the greatest possible extent, to be careful that none of such animal or vegetable substances as are capable of being converted into manure, be thrown away or consumed by fire; but that they be all conveyed to the dung-steads in the farm-yards or other places, or laid in heaps of themselves, and suffered to pass into fermentation, by which they may be speedily reduced to manure. Where the matter thus made use of chiefly consists of weeds, and the stems or roots of coarse plants, such as peas, beans, cabbages, docks, nettles, &c., their decay may be greatly promoted by a little quick-lime being blended with them. Such heaps should also be covered over pretty well with some of those earthy matters that have been so frequently mentioned.

As we have seen that the different materials which are made use of for the purpose of manure, pass through different stages of decomposition and decay, in each of which such matters of the solid or fluid kinds are formed, as are capable of contributing to the nutrition and support of vegetable crops, but which are liable to be dissipated or carried away by the agency of various causes, it may be necessary to guard against such waste by keeping the dung-heaps covered, in every situation, as much as possible, with earth or soil, both in the early periods in which heat is evolved, and at the later ones, when ammonia or volatile alkali is formed; as by such management the processes of decomposition, when too rapid, may be restrained, and the elastic matters that are gradually set at liberty be absorbed by these coverings, while the more fluid ones are detained by the earthy bottoms on which they had been placed, and thus the whole of the valuable properties of the manure be preserved.

General Application of Manures.—In the application of manure to land, several circumstances are necessary to be considered; such as the state or condition of the substances which are to be made use of, the nature of the soils on which they are to be laid, the kind of crop that is to be promoted by them, and the season in which they are put into or upon the ground.

As we have already seen that changes are continually taking place from the moment the materials of the dung-heap are thrown together, to the period in which they are reduced into a black carbonic earthy matter; and that, in most of the different stages through which they pass in this process of decomposition, such substances are formed as are capable of contributing to the nutrition and support

of vegetable crops; it seems probable, that in cases where manures are to be turned into the ground, and such crops cultivated as require a supply of nourishment for a considerable length of time, they should be employed in their long or more imperfectly reduced states, as, by the heat which is evolved in the commencement of their dissolution, the process of early vegetation may be greatly promoted, and their gradual decomposition and decay afterwards, under the ground, afford a more durable and regular supply of nutrient materials, and thereby contribute more effectually to the growth of the crops; but that where they are to be buried in, or applied to the surface of the soil, and intended merely for the benefit and support of such crops as are of short duration, or quickly arrive at their full growth, they may be more advantageously made use of after they have been more fully and completely reduced, as in this state the manure is, in the case of grass-lands, not only capable of being spread out in a more regular and uniform manner, by which it becomes more evenly as well as more generally carried down to the roots of the plants by rains, but it is in the most suitable condition for allowing the young plants the means of springing up with facility, and at the same time, whether used under or upon the soil, of affording the crops that abundant supply of nourishment which is necessary to their speedy growth and great luxuriance, and by these means to contribute the most perfectly to the promotion of their increase.

Beside the above advantages of long or imperfectly decayed manures, they have others that depend on the soil into which they are turned, and the nature of the crops that are sown or planted with them. Where they are employed in such stiff, clayey, or loamy grounds, as have a great tendency to become dry and hard, and thereby incapable of admitting the tender fibrous roots of grains or other plants to spread or extend themselves, and draw in more abundant supplies of nourishment, they may be useful by keeping the earth around them in a more open and porous state, from the slowness of their decomposition, and the gradual and continued manner in which the different elastic matters are set loose and united with the soil. Hence, when barley, or such kinds of grain as require a rather light and open state of soil, and those bulbous or knobby-rooted plants, such as potatoes, that require much room to shoot and extend themselves, are cultivated on such stiff soils, they are generally found to be the most productive where such long or imperfectly reduced manures have been made use of in the preparation of the land.

And as in the slow and gradual decomposition of the materials which are made use of for manures, when slightly deposited beneath the soil, there is much less waste of heat and those elastic matters which contribute so greatly to the support of vegetation, than where they are made to undergo the various processes of dissolution in large masses, as in dung-heaps, they may probably sometimes on that account be most advantageously employed in this state.

On this principle, too, the ploughing down of fresh vegetable crops, in many cases, in their most succulent states, may be a more œconomical as well as more beneficial practice, (especially in such light and dry kinds of soil as will more readily admit of their gradual

putrefaction and decay,) than to cut and take them off for the purpose of being by other means converted into manure. It seems likewise probable, on the same grounds, that, for the production of crops of bulbous-rooted vegetables on the more stiff and tenacious soils, the matters made use of as manures may be employed with the greatest advantage, when put into the earth before they have undergone any great degree of decay by means of putrefaction, as in this way there is no waste, the whole being ultimately converted and applied, though more slowly, to the support of the crops.

As to the season in which manures may be put into the soil, or spread out upon its surface, with the greatest benefit and advantage, though in practice it must, in some measure, depend on the state of the land and the convenience of the farmer, it should, in cases where they are buried in the ground, be as nearly as possible to the periods in which the seeds of the roots, which they are designed to support, are sown or placed in the earth; and in the latter case, or where they are to be laid upon the surface of the land, it ought probably to be just before the crops of grass, or other vegetables, begin naturally to spring or shoot forth.

By the practise of depositing and blending the manure with the soil, nearly at the time the crops are put in, there is scarcely any waste of the fertilizing properties of such substances, which, as they gradually proceed in their decomposition and decay under the ground, must otherwise be the case, the roots of the plants not being in the most proper states for taking them up and converting them to their support. Besides, in the stiff, loamy, or clayey soils, they have a tendency, as has been remarked above, to produce a degree of lightness and friability that is suited to the early process of vegetation. And it is observed by an able writer, that "the atmospheric air, which is buried along with the manure in the interstices of the earth, and which for many weeks, or even months, renders the soil loose and easily impressed by the foot on walking on it, gradually evolves, by its union with carbon, a genial heat, very friendly to vegetation in this climate, as well as the immediate production of much fluid carbonic acid, and probably of a fluid mixture of nitrogen with hydrogen, which are believed to supply much nutriment to plants."

And by the application of such manures as are employed in the way of top-dressings in the beginning of the spring, they are laid on in the most favourable period for affording their nutritious principles, and for their being drunk up by the roots of plants; consequently become useful at the time they are most wanted for the promotion of the crops; and the great waste which must otherwise be caused, either by the excessive falls of rains and floods in the winter season, washing down much of the valuable properties into the adjoining rivers and ditches, or the evaporation of their more volatile or elastic matters by means of the summer heats, is most effectually guarded against and prevented.

The practice common in some places of applying manure to grass lands in the latter end of summer or beginning of autumn, after the first crop of hay has been taken from the ground and the after-grass has begun to make shoots, is not by any means so favourable as that

of early spring, as in the latter case the generation of those materials that contribute to the support of vegetation is greatly promoted by the constantly increasing heat of the vernal and summer months; while in the former it is constantly checked and retarded by the increasing coldness of the autumn and winter seasons. Besides, the manure, by being spread out upon the surface of the land, under such circumstances, must be the cause of great loss, by contaminating the after-grass, and rendering it incapable of being eaten off by cattle or other kinds of live stock.

Where, however, a second crop of hay is to be taken, it may sometimes be put on at such times with advantage to such crop, especially if the weather be not too hot, and the manure in a perfectly fine and reduced state.

Doctor Fenwick, in his very ingenious reflections on manures, has very well observed, that it is scarcely possible to suggest a worse mode of using manures on grass lands, than that which is almost universally practised in the neighbourhood in which he resides; and it is the same in many other parts of the country, as is evident from the reports that have been lately published under the authority of the Board of Agriculture: "When a severe frost has bound up the land in a state of impenetrable cohesion, the farmers," says he, "wheel on their dung, perhaps even when snow has covered it. While the frost lasts the land can derive no advantage from the manure, and when a thaw supervenes it is evident that the wash from the melting snow, or from the rains which generally fall in such weather, must deprive the mass of every part that is soluble. The ground, in the mean time, retains the frost for many days, and is therefore incapable of absorbing the wet which falls upon its surface; and even when the influence of the milder air has reached it, it can imbibe but little, being in general previously filled with water, and the quantity which flows over it being too great for soil under any circumstances to drink up."

In favour of this destructive and wasteful practice, however much it may have been defended on the ground of the farmer's leisure or convenience, and the little injury done to the turf or sward of the land, the same writer thinks there can be only one reason alleged, which is, that manure, when spread early in the winter, may protect the roots of grasses from the severity of frosts. This too is probably a mistaken notion, as it is known to every one that the common grasses are seldom injured by the severest frosts; and other kinds of grasses may probably not suffer less injury from the application of manure at such a season, than from the severity of frosts.

On all these accounts, therefore, farmers should contrive as much as possible to apply the manures intended as top-dressings to grass lands, as early in the spring as it can be conveniently done; which may be easily managed on those that are dry; and on such as are inclined to be wet and poachy, it may probably be greatly facilitated by having small light carts constructed for the purpose, and placed on broad cylinders as wheels. We are fully convinced, from the trials which we have made in applying manures to grass lands at such periods, that the trouble of the farmer will not only be rewarded by much larger crops of hay, but also by a considerable increase in the quan-

tity of the after-grass; and, besides, his crops in both instances will be more forward than in the ordinary methods of putting them on, either in the autumn or the winter months; which in many cases is a circumstance of great importance.

In the application of manures to lands under tillage, as well as those in the state of grass, there are a few other circumstances that require the attention of cultivators; such as the depth they may be deposited in the soil, the modes of putting them upon the ground, and the most œconomical methods of employing them.

As we have already seen that the putrefaction and decay of animal and vegetable matters, whether above or beneath the ground, is greatly promoted by the free admission of air and a suitable degree of moisture to them, it is evident that they should not be buried so deep in the earth, as that they may be prevented from readily receiving the aid of such causes in forwarding their decomposition; nor, as the process is known to be much retarded by the substances being rendered too dry, should they be placed so near the surface, or be so thinly covered, as to permit the action of the sun and winds, before the crops have risen to such heights as to prevent it, from dissipating and carrying away their nutritious properties. The introduction of the manure to a middling depth, as three or four inches, would therefore, on these accounts, as well as from its contributing more expeditiously and more fully to the vegetation of the crops that may be put in with it, seem, in general, to be the most advantageous practice; but, on the lighter and more friable soils, it may be advisable to plough it in to a greater depth than in such as are heavy and tenacious. In every case, however, whether the manure made use of be in a long or a more reduced state, it should be perfectly covered or ploughed into the earth. The practice of burying manures deep in the soil has been defended by some, on the ground of its being the nature of elastic matters to rise or force themselves towards the surface; but when they are placed to a considerable depth in the earth, as the process of decomposition is thereby stopped, or suffered to proceed in but a very slow and feeble manner, little or nothing escapes for the support of vegetation, or it is furnished in so very slow and sparing a way, as to be of scarcely any service to the immediate crops. Thus, in the cultivation of such crops as are placed in rows or drills, where the manure is put in to a great depth and covered pretty thickly with earth, on digging them up at the end of many months it may frequently be observed nearly in the same state it was when first put into the ground. And the same thing is often noticed by gardeners, where imperfectly reduced or long dung is placed in deep trenches and covered to a considerable thickness with mould.

The nature and methods of applying manures to tillage lands, will be more fully considered in speaking of putting in different sorts of field crops.

In order that manures may produce their effects in the most perfect way, they should be spread over the surfaces of the grounds as evenly as possible, whether they be intended to be turned into the soil, or left upon its surface as top-dressings. This may be greatly facilitated by placing the manures out at at first in very small heaps, as by such

a practice it may be spread over the ground with much greater ease and exactness; and on grass-lands much less injury will be done by the bottoms of the heaps.

On tillage lands, manures should always be turned in, or otherwise covered, as soon as possible after they are spread out; for, if this be neglected, much loss may be sustained, especially in hot seasons, by the quick evaporation that takes place in such cases. The best practice is, therefore, not to carry more out from the dunghill at a time, than can be conveniently spread upon and ploughed into the earth in a short time afterwards. In spreading manures employed as top-dressings on grass lands, much advantage will be gained by breaking and reducing the clods or lumps into as fine a state as possible, as by such means they are not only applied more perfectly, but washed by the rains much more readily to the roots of the grasses. The springing of the young grasses is also less retarded where the manures are rendered fine and powdery, than where they are left in a cloddy state. But the most advantageous methods of making use of manures of different sorts upon new lays and other descriptions of grass-land, will be more fully detailed in treating of the nature of grass husbandry.

In the use of manures, is seems not improbable but that some degree of saving may occasionally be made, as has been already recommended, by applying them on lands under tillage, as well as others, nearly at the time the seeds and roots are put into the ground, or when the grasses begin to shoot; as, from the whole of the manure being in this way made to contribute directly to the support of the crops, a less quantity may be sufficient for the purpose: how far they may be safely diminished on this principle, can only be shown by actual experiments and accurate deductions made from them; but there are sufficient grounds, from what has been observed, for supposing that it may be considerably more than can be easily apprehended by those who have not adverted much to this circumstance. Another œconomical mode of employing manure is, by placing it in the drills or hollows formed for the reception of different crops which are cultivated in rows, as peas, beans, cabbages, potatoes, &c.: by this method, that part of the ground which is intended to bear the crop, is only manured, the intervals or spaces between the rows not receiving any; from which, where the business of putting the manure into the drills is properly performed, a great saving must of course be made.

As it appears probable that, in the decay of different materials in the soil, all the nutritious matters as they are formed immediately become useful for the purpose of vegetation, without any waste being sustained, as must always be more or less the case where they are deposited together in heaps, it may be an œconomical practice, as has been already observed, in cases where the crops to be benefitted by them require a regular and lasting but not large supply of nourishment, or where the ground is required to be kept in an open and rather light state, for a considerable length of time, to employ such manures in their less decomposed states, as by the ploughing down of green succulent vegetable crops, and the turning in of long strawy substances. By adopting such means, the more perfectly formed manures of the farm may be reserved for such crops of lux-

uriant vegetables as demand more speedy and abundant supplies of nutrient matters.

In respect to the advantage of using one sort of manure in preference to another, it may be observed, that as animal matters are found in general to undergo more speedily the process of putrefaction or decomposition, than those of the vegetable kind, and as in most instances they afford those mucilaginous and elastic principles that contribute so largely to the support of vegetable life in greater proportions; such manures as are either wholly or in a great measure composed of them, must be the most beneficially employed where quick and abundant supplies of nourishment are required, as in the growth of all the more gross and luxuriant crops, whether of grain, plants, or grasses; and that as those vegetable substances which contain saccharine, farinaceous, oily, saline, or mucilaginous principles, in the largest quantities, are ascertained from experience to proceed the most readily into the state of dissolution or decay, and consequently to afford more fully and more expeditiously the nutrient food of new plants; where manures are principally formed from them, they should be preferred to such as have been made from the harder and more ligneous vegetable substances, that contain such properties in scarcely any, or much smaller degrees, for all the purposes of agriculture.

And lastly, such substances as are found to contain those elementary materials, of which vegetables are principally constituted in their more soluble or loosely combined states, as carbonaceous matter in the black earths or moulds, and oxygen, azote and hydrogen, in burnt clay, raddle, manganese, and calamy, substances which have hitherto been little employed, as well as in water and air, should be made use of in preference to those which possess them in slight proportions or scarcely at all.

SECTION VIII.

Draining of Land.

ALTHOUGH it has been clearly shown, by the various experiments and observations that have been made on the nature of vegetation, that a large proportion of water is essentially necessary for the support of the healthy growth of plants, and which will be still further explained in speaking of the application of it to grass-lands, it is evident that it may exist in such over-quantities, or be so retained in or upon the soil, as to prove not only highly injurious to the growth of the crops, whether of grain or grass, but likewise prejudicial to the health of those who inhabit the districts where it is suffered thus to become stagnant. It therefore becomes the business of the farmer, in such cases, to attempt the removal of those prejudicial excesses of moisture, before he commences any other

operations for the purpose of improving such lands; as, without fully accomplishing this object in the first instance, all his future exertions will be of but little avail. This may, in most instances, be accomplished by means of draining, a practice the successful execution of which, in a great measure, depends on a proper knowledge of the structure of the earth, and of the various strata of which it is composed, as well as of their relative degrees of porosity, or capability of admitting or rejecting the passage of water through them, and likewise the modes in which water is formed, and conducted from the high or hilly situations to the low or level grounds. In whatever way the hills or elevations that present themselves on the surface of the globe were originally formed, it has been clearly shown, by sinking large pits, and digging into them, that they are mostly composed of materials lying in a stratified order, and in oblique or slanting directions downwards; some of which strata, from their nature and properties, are capable of admitting water to percolate or pass through them, while others do not allow it any passage, but force it to run or filtrate along their surfaces without penetrating them in any degree, and in that way to conduct it to the more level grounds below, till it becomes obstructed or dammed up by meeting with impervious materials of some kind or other, when it is readily forced up into the super-incumbent layers where they happen to be open and porous, soon rendering them too wet for the purposes of agriculture: but where they are of a more tenacious and impenetrable quality, they only become gradually softened by the stagnant water below them; by which the surface of the ground is, however, rendered equally moist and swampy, though somewhat more slowly than in the former case. It may also be observed, that some of the strata which constitute such hilly or mountainous tracts are found to be continued with much greater regularity than others; those which are placed nearest to the surface at the inferior parts of such hills, or elevations, being mostly broken or interrupted before they reach the tops or higher parts of them, while those which lie deeper, or below them at the bottom, show themselves in these elevated situations. Thus, that stratum which may lie the third or fourth, or still deeper, at the commencement of the valley, may be the most superficial, or form the uppermost layer, on the summits of hills or mountainous elevations. This arrangement or distribution of the different strata may have been produced partly by the circumstances attending the original elevation of such mountainous regions, and partly from the materials of the original exterior strata being dissolved and carried down into the valleys by successive rains, and other causes, and thus leaving such as were immediately below them in an exposed and superficial state in these elevated situations.

But in whatever way or from whatever causes it may have happened, that those strata which are placed at considerable depths at the bottoms of hills, and other more elevated regions, present themselves and become superficial upon their summits, it is evident that they frequently prove the means of rendering the grounds below wet and swampy; for, from the night dews, and the general moisture of the atmosphere, being condensed in much greater quantities in

such elevated situations; from their greater coldness, or other causes, than in those level surfaces which are below the water thus formed, as well as that which falls in rain and sinks through the superficial porous materials, readily insinuate themselves, and thus pass along between the first and second, or still more inferior, strata which compose the sides of such elevations, until their descent is retarded or totally obstructed, as has been just shown, by some impenetrable substance, such as clay; it there becomes dammed up, and ultimately forced to filtrate slowly over it, or to rise to some part of the surface, and constitute, according to the particular circumstances of the case, different watery appearances in the grounds below; such as oozing springs, bogs, swamps, or morasses, weeping rocks from the water slowly issuing in various places, or a large spring or rivulet from the union of small currents beneath the ground. This is obvious from the sudden disappearance of moisture on some parts of lands, while it stagnates, or remains till removed by the effects of evaporation, on others; as well as from the force of springs being stronger in wet than dry weather, breaking out frequently after the land has been impregnated with much moisture in higher situations, and as the season becomes drier ceasing to flow, except at the lowest outlets. The force of springs, or proportion of water which they send forth, depends likewise, in a great measure, on the extent of the high ground on which the moisture is received and detained, furnishing extensive reservoirs or collections of water, by which they become more amply and regularly supplied. On this account, what are termed bog-springs, or such as rise in valleys and low grounds, are considerably stronger and more regular in their discharge, than such as burst forth on the more elevated situations or the sides of eminences.

The waters condensed in the manner described above on the tops of elevated regions, are sometimes found to descend, for a very considerable distance, among the porous substances between the different conducting layers of clayey or other materials, before they break out or show themselves in the grounds below; but it is more frequently the case to find them proceeding from the contiguous elevations into the low grounds that immediately surround them.

The nature and regularity of the stratum of materials, on which the water proceeding from the summits of hills has to filtrate and slide upon, must considerably influence its course, as well as the effects which it may produce on such lands as lie below, and into which it must pass; as, where it is of the clayey, stiff marly, or impervious rocky kinds, and not interrupted or broken by any other kind of materials of a more porous quality, it may pass on to a much greater distance, than where the stratum has been frequently broken and filled up with loose porous materials, in which it will be detained, and of course rise up to the surface.

It is for the most part on the clayey, stiff close marly, and unfractured stony strata, that water is conducted from the hills and more elevated grounds into the plains and valleys which are below them.

These sorts of strata extend to very different depths in different

situations and districts, as has been frequently noticed in the digging of pits, and the sinking of deep wells, and other subterraneous cavities. The clayey strata are, however, in general found to be more superficial than those of the compact, tenacious, marly kinds, or even those of a firm, uninterrupted, rocky nature, and seldom of such a great thickness; they have, nevertheless, been observed to vary greatly in this respect, being met with in some places of a considerable thickness, while in others they scarcely exceed a few inches.

The intervening porous substances or strata where clay prevails are found, for the most part, to be of either a gravelly or loose rocky nature. Stiff marly strata, which approach much to the quality of clay, though in some instances they may present themselves near the surface, in general lie concealed at considerable depths under the true clayey, and other layers of earthy or other materials: they have been discovered of various thicknesses, from eight or ten feet to considerably more than a hundred. The intervening materials, where strata of this nature are predominant, are most commonly of the more sandy kinds, possessing various degrees of induration, so as in some cases to become perfectly hard and rocky, but with frequent breaks or fissures passing through them. The loose, friable, marly strata are capable of absorbing water, and of admitting it to filtrate and pass through them.

It may be concluded from this view of the nature and arrangement of the various stratified materials that constitute the earth, and the manner in which water is formed on the more elevated and hilly situations, and brought down from them, that the valleys and more level grounds below must constantly be liable to be overcharged with moisture, and, as has been already shown, to become in consequence of it spouty, boggy, or of the nature of a morass, accordingly as they may be circumstanced in respect to their situation, the nature of their soils, or the materials by which the water is obstructed and detained in or upon them.

Where lands have a sufficient degree of elevation to admit of any over-proportion of moisture readily passing away, and where the soils of them are of such an uniform sandy or gravelly and uninterrupted texture, as to allow water to percolate and pass through them with facility, they can be little inconvenienced by water coming upon or into them, as it must of necessity be quickly conveyed away into the adjacent rivers or small runlets in their vicinity.

But where grounds are in a great measure flat, and without such degrees of elevation as may be sufficient to permit those over-proportions of moisture that may have come upon them from the higher and more elevated grounds, (either in the way that has been shown above, or from the overflowing of rivers and smaller streams of water that may pass through or near them, and from the falling of heavy rains), to readily pass away and be carried off; and where the soils of the lands are composed or constituted of such materials as are liable to admit and retain the excesses of moisture that may in any of these ways come upon them; they must be exposed to much injury and inconvenience from the retention and stagnation of such

quantities of water, and consequently require artificial means to drain and render them capable of affording good crops, whether of grain or grass: and, lastly, lands of valleys and other low places, as well as, in some cases, the level tracts on the sides or borders of large rivers and of the sea, (from the peculiarity of their situations, and their being composed in a great measure of porous or spongy materials, formed by the dissolution and decay of various coarse vegetable and other matters, which are produced on them, or which have been gradually, for a vast length of time, washed down and brought into them from the hills and rising grounds by rains and other causes, or deposited by means of floods, so as to form different degrees of accumulation, according to the difference of situation or other circumstances), must also frequently be subject to great injury and inconvenience from their imbibing and retaining the water that may be thus forced to flow up into or upon them, either through the different conducting strata from the hills and mountainous elevations in the neighbourhood, or the porous materials of the soils; as in these ways they may, as we have already seen, be rendered swampy, and have bogs or morasses produced in them in proportion to the predominancy of the materials by which the water is absorbed and dammed up, and the peculiarity of the situation of the lands in respect to the means of conveying it away.

On these grounds, besides a knowledge of the nature and inclination of the various strata that compose the interior parts of the earth, it is clear that, in order to properly perform the business of draining, attention should not only be paid to the discrimination of the differences in regard to the situation of the lands, or what is commonly denominated drainage level, but also to the nature, distribution, and depth of the materials that constitute the soils or more superficial parts of them, as upon each of these some variety in respect to the effects arising from water retained in them may depend.

But though there may be considerable diversity in the effects which water produces in or upon lands from these different causes, wetness of land, so far as it respects agriculture, and is an object of draining, may generally depend on the two following causes: first, on the water which is formed and collected on or in the hills or higher grounds, in the manner which has been explained, filtrating and sliding down among some of the different beds of porous materials that lie immediately upon the impervious strata, forming springs below and flowing over the surface, or stagnating underneath it; secondly, on rain or other water becoming stagnant on the surface, from the retentive nature of the soil or surface materials, and the particular nature of the situation of the ground. The particular wetness which shows itself in different situations, in the forms of bogs, swamps, and morasses, for the most part proceeds from the first of these causes; but that superficial wetness which takes place in the stiff, tenacious, clayey soils, with little inclination of surface, generally originates from the latter.

From the ideas which have been suggested respecting the nature and formation of the different strata that compose the earth, and of the manner in which water slides, filtrates, or passes down among or

between them, and forms springs, (which, according to circumstances, render the grounds below boggy, swampy, or too wet for the purposes of agriculture), it is evident that the best and most certain, as well as the most expeditious, method of draining, in such cases, must be that of intercepting the descent of the water or spring, and thereby totally removing the cause of wetness. This may be done where the depth of the superficial strata, and consequently of the spring, is not great; which may be previously known by the use of a draining auger, by making horizontal drains of considerable length across the declivities of the hills, about where the low grounds of the valleys begin to form, and connecting these with others made for the purpose of conveying the water thus collected into the brooks or runlets that may be near. And as the strata between which the water passes down to produce such springs have, for the most part, nearly a similarity of inclination with that of the surface of the hill or rising ground, the auger holes of the drains should not, as is the general practice, be made directly downwards, but perpendicularly to the surface of the elevation, as in this way the stratum on which the water passes down may be more readily dug to, and the water drawn off; or where the spring has naturally formed itself an outlet, it may frequently only be necessary to render it larger, and of more depth; which, by affording the water a more free and open passage, may evacuate and bring it off more quickly, or sink it to a level so greatly below that of the surface of the soil, as to prevent it from flowing into or over it.

But where the springs, from the great thickness of the upper stratum, are confined at such a depth beneath the surface as that they injure it, by rendering it constantly moist, or by imperceptibly oozing through it, but afford no marks of any particular outlets: and where a drain cannot be cut so deep as to come to them, either on account of the great difficulty of doing it or the expense that must attend it, or where the level of the outlet will not allow of its being cut to that depth; it will be necessary, after cutting ditches in the way that has been just explained, to perforate the soil beneath by means of a boring instrument considerably deeper, so as to reach the spring, and thus give free vent to the water collected below;—a method of practice which seems long ago to have been ingeniously suggested by Dr. Anderson, and since more fully and more particularly applied by Mr. Elkington.

Where this can be effectually accomplished, such a number of perforations should be made as will allow the confined water to pass readily into the drains, and be conveyed by the connecting ditches to the adjoining streams of the neighbourhood: in these cases, the water coming freely into the drains several feet below the moist surface of the land, and being then conducted away, will not be forced up through the superincumbent materials of the soil to the surface, which is so much higher.

As in cases of this kind, where, after boring in this manner, the water breaks forth with considerable violence, it may sometimes be apt to bring up with it such quantities of sand, or other substances, as may block up the holes and prevent the free exit of the water, it

may be necessary to apply the auger frequently in order to remove it. A striking instance of this kind is related in the Philosophical Transactions, where, on the sinking of a well four feet wide and 236 feet deep, and then boring some feet deeper with a five-inch borer, so much sand was forced up by the impetuosity of the water that broke forth as to fill the well, and which on being cleared away by buckets in its liquid state, suffered the water to flow over the surface in the quantity of forty-six gallons in a minute.

There may be still other situations of lands, as where the uppermost stratum is so extremely thick as not to be easily penetrated, or where the springs, formed by the water passing from the higher grounds, may be confined beneath the third or fourth strata of the materials that form the declivities of hills or elevated grounds, on account of so many of them becoming deficient on their tops, or more elevated parts, and by this means lie too deep to be penetrated to by the cutting of a ditch, or even by boring; and still, from the water being obstructed by the different materials forming the plains below, may be forced up to the surface, and produce different kinds of injurious wetness.

In such cases, the common mode of cutting a great number of drains to the depth of five, six, or more feet, across the wet morassy grounds, and afterwards covering them in such a manner as that the water may suffer no interruption in passing away through them, may be practised with advantage, as much of the prejudicial excess of moisture may by this means be collected and carried away, though not so completely as by fully cutting off the spring.

As water is sometimes found to be conveyed from the hills and high grounds at no great depth beneath the surface of the land upon thin layers of clay, which have underneath them sand, stone, or other porous or fissured strata, to a considerable depth; by perforating these thin layers of clay in different places, the water which flows along them may frequently be let down into the open, porous materials that lie below them, and the surface land be thus completely drained.

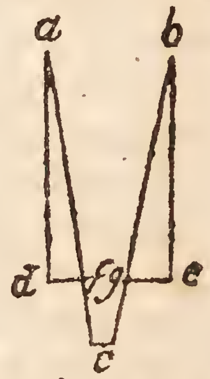
In those situations of land where morasses and other kinds of wetnesses are formed in such low places and hollows as are considerably below the beds of the neighbouring rivers, they may, probably, in many instances, be effectually drained by arresting the water as it passes down into them from the higher grounds, by means of deep drains cut into the sides of such hills and rising grounds, and, after collecting it into them, conveying it away by pipes, or other contrivances, at such high levels above the wet lands as may be necessary: or where the water that produces the mischief can by means of drains, cut in the wet ground itself, be so collected as to be capable of being raised by means of machinery, it may in that way be removed from the land.

The drainage of those extensive tracts of land that in many districts lie so greatly below the level of the sea, can only be effected by the public, and by means of locks erected for the purpose of preventing the entrance of the tides, and by windmills and other

expensive kinds of machinery constructed for the purpose of raising the stagnant water.

The superficial wetness of lands, which arises from the stiff retensive nature of the materials that constitute the soils and the particular circumstances of their situations, is to be removed in most cases by means of hollow superficial drains, judiciously formed, either by the spade or plough, and filled up with suitable materials where the lands are under the grass system, and by these means and the proper construction of ridges and furrows where they are in a state of arable cultivation.

The ordinary method of forming these superficial drains is to excavate channels in the form of a wedge, that is to say, with the smooth sides narrow at the bottom and diverging towards the surface of the earth: thorns and straw are then stamped firmly in with the foot, and the drains are covered over with mould. Unless the soil be very stiff and tenacious, the sides of the drains are very liable to be torn by the force with which the thorns are pressed in; and the channel, which ought to be preserved quite open at the bottom, oftentimes half choked by the loose earth which crumbles in. Instead, therefore, of forming the drains in the ordinary shape, it is perhaps better to make a shoulder for the thorns to rest on; thus, *ac* and *bc* represent the smooth sides of an under-drain, as it is usually formed:—rather than form the sides thus approaching to each other at the bottom, it is *perhaps* better to cut down perpendicular the two dotted sides *ad* and *be*, leaving the sides, and the shoulders *df* and *ge* for the thorns to rest on. Below this shoulder the water has an uninterrupted channel for its course. At the mouth of the drains, that is, where they discharge themselves into the ditches, it is advisable to lay a small plank transversely. Sheep in the summer time run into ditches and without some such preservative as this, they are likely to scratch a quantity of mould into them.



The advantages of draining have been exhibited with singular effect in the neighbourhood of East Devon. Mr. Munning informs us, that at Michælmas, 1795, Mr. Salter of Winburgh entered upon the occupation of more than eight hundred acres of *heavy* land, which had been so entirely neglected by his predecessor, as to be almost altogether what it ought *not* to have been.

Mr. Salter immediately saw, that unless he could get rid of the surface-water all his labour must be fruitless, and his money expended in vain; he therefore began his operations by cutting 342 rods (of 7 yards to the rod) of *river* through the centre of the farm, 7 feet wide and 6 feet deep perpendicularly, in order to obtain an outlet for the water to flow from his other works: he cut 2937 rods of new and old ditches, 6 feet and 5 feet deep perpendicularly: 1116 rods of open drains, of various widths and depths, from 4 to 5 feet wide, and from 3½ to 4½ feet deep perpendicularly; and he cut and filled up 4871 rods of under-draining, of which the leading drains were 36 inches, and the feeding drains to the same 30 inches deep

perpendicularly. The whole of this work was executed and completed in one year! Mr. Salter has continued to do a great deal every year since 1795: between Michaelmas 1800 and Michaelmas 1801, he executed 4423 rods of under-draining of widths and depths as before expressed; and he is now going on with the spirit and the judgment of an experienced and an understanding agriculturist. The effect has been, that on the land which was so much impoverished by stagnant water, and so much inundated by land-springs, as not to reproduce the seed used upon it, his crops have been abundant; and while Mr. Salter reaps the benefit of his judicious exertions, he may very fairly be regarded as a public benefactor. He may almost be considered as producing a new creation around him, and should be held up, by every friend to agricultural improvement, to the admiration and the imitation of all who have to do with heavy land from which it is necessary to remove the surface-water.

Methods of Draining Boggy Land.—In the drainage of wet or boggy grounds, arising from springs of water beneath them, a great variety of circumstances are necessary to be kept in view. Lands of this description, or such as are of a marshy and boggy nature, from the detention of water beneath the spongy surface materials of which they are composed, and its being absorbed and forced up into them, are constantly kept in such states of wetness as are highly improper for the purpose of producing advantageous crops of the kind. They are, therefore, on this account, as well as those of their occupying very extensive tracts in many districts, and being, when properly reclaimed, of considerable value, objects of great interest and importance to the attentive agricultor. Wet grounds of these kinds, from the nature of their situations, and the modes of draining them, are arranged by a late practical writer under three distinct heads; first, such as may be readily known by the springs rising out of the adjacent more elevated ground, in an exact or regular line along the higher side of the wet surface; second, those in which the numerous springs that show themselves are not kept to any exact or regular line of direction along the higher or more elevated parts of the land, but break forth promiscuously throughout the whole surface, and particularly towards the inferior parts, constituting shaking quags in every direction that have an elastic feel under the feet, on which the lightest animals can scarcely tread without danger, and which, for the most part, show themselves by the luxuriance and verdure of the grass about them; third, that sort of wet land, from the oozing of springs, which is neither of such great extent, nor in the nature of the soil so *peaty* as the other two, and to which the term *bog* cannot be strictly applied, but which in respect to the modes of draining is the same.

In order to direct the proper mode of cutting the drains or trenches in draining lands of this sort, it will be necessary for the operator to make himself perfectly acquainted with the nature and disposition of the strata composing the higher grounds, and the connection which they have with that which is to be rendered dry. This may in general be accomplished by means of levelling and carefully at-

tending to what has been already observed respecting the formation of hills and elevated grounds, and by inspecting the beds of rivers, the edges of banks that have been wrought through, and such pits and quarries as may have been dug near to the land. Rushes, alder-bushes, and other coarse aquatic plants, may also, in some instances, serve as guides in this business; but they should not be too implicitly depended on, as they may be caused by the stagnation of rain-water upon the surface, without any spring being present.

Fig. 1. in plate LXXII. explains the method of draining practised by Mr. Elkington in the first class of spring bogs, as delineated by Mr. Johnstone. And fig. 2. is a section of the same drainage, when the stratum of clay, where the trench is cut, is thicker than the level of the orifice will permit the depth of the drain to be, A being the depth of it at that level. The rest of the clay, from A to B, is to be perforated by an auger to the lower point of the porous stratum at D, when the water will rise up in the trench from the pressure above the level of the drain.

Fig. 3. represents the mode of drainage in the second class of spring bogs on Mr. Elkington's principles, as explained by Mr. Johnstone. And fig. 4. is a view or section of the same.

Where the impervious stratum, that lies immediately beneath the porous, has a slanting direction through a hill or rising bank, the surface of the land below that level will, in general, be spongy, wet, and covered with rushes on every side; while the higher side of it will be found to deviate very slightly from a level in any part round it. In this case, which is not unfrequent, a ditch or drain, properly cut on one side of the hill or rising ground, may remove the wetness from both, as shown in the plan, in which fig. 1. in plate LXXIII. represents the plan of draining pursued by Mr. Elkington in such hilly situations; and fig. 2. is a view or section of this drainage, as given by Mr. Johnstone.

But where the impervious stratum dips or declines more to one side of the hill or elevation than the other, the water will be directed to the more depressed side of that stratum; the effect of which will be, that one side of such rising ground will be wet and spongy, while the other is quite free from wetness.

In the practical management of draining land, it will be necessary after this to determine which of the places at which water issues forth on the surface, if there be more than one, is the real or principal spring, and that from which the other outlets are fed; as upon this must depend the direction of the ditch or drain, as by removing that the others must of course be rendered dry. When on the declivity or slanting surface of the elevated ground from which the springs break forth, they are observed to burst out at different levels according to the difference of the wetness of the season, and where those that are the lowest down continue to run, while the higher ones are dry, it is, in general, a certain indication that the whole are connected, and proceed from the same source; and consequently that the line of the drain should be made along the level of the lowermost one, which, if properly executed, must keep all the others dry. But if, as has been the too frequent practice, the drain

Pl. LXXII. 8°

DRAINAGE OF BOGGY LANDS FROM SPRINGS.

Fig. 2.

A. Dry porous Soil, receiving the Rain Water.
B.B Gravel &c. containing Springs.
a.a. Level of Drains orifice at the Brook.
b. Outlet of Springs.
c. The Water breaks out when the Springs are full.

Fig. 1.

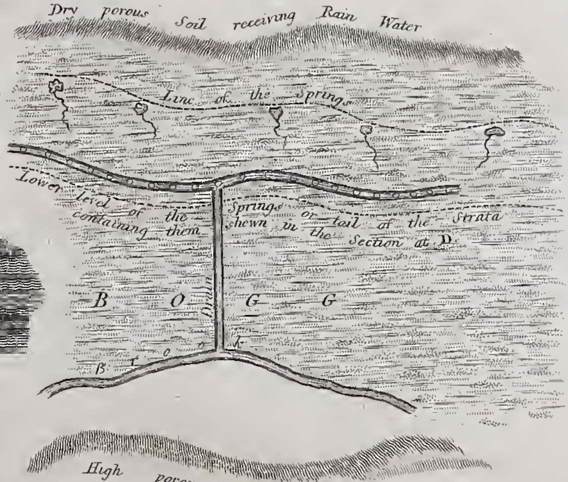


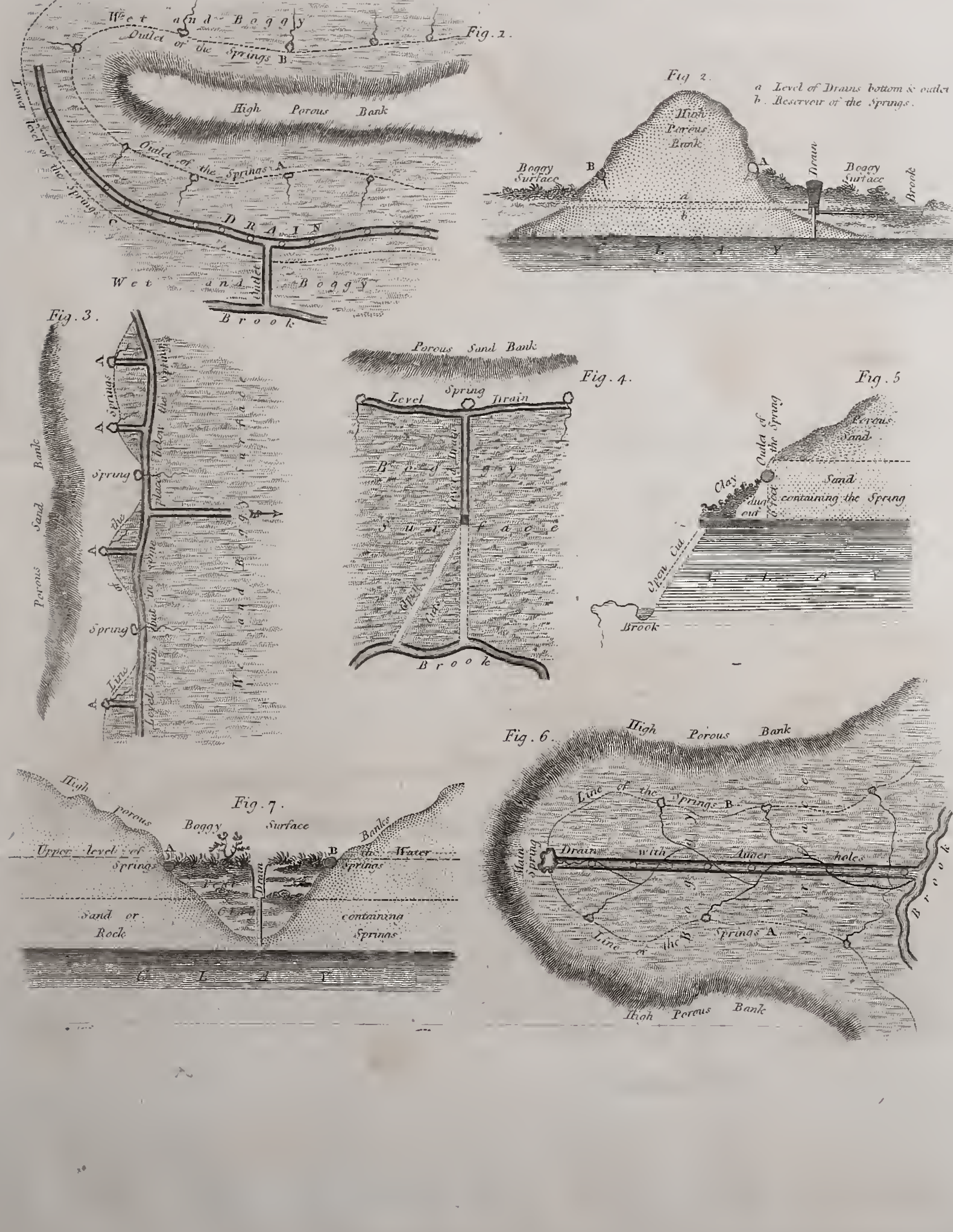
Fig. 4.

A. High porous Ground.
B. Upper level of the Water.
C.C. Gravel &c containing Springs.
D. Outlet.
a.a.a. Boggy Surface.
b.b. Springs.
c.c. Clay
d.d. Peat Earth.
x. Main Spring
y. Level of the outlet.

Fig. 3.

A.A.A. Springs.
D.D.D. Drain cut along the Level of the lower Springs.
E. Outlet.

DRAINAGE OF BOGGY & WET LANDS.



was made along the line of the highest of the outlets, or places where the water breaks forth, without being sufficiently deep to reach the level of those below, the overflowings of the spring would merely be carried away, and the wetness proceeding from that cause be removed; while the main spring, still continuing to run, would render the land below the level of the bottom of the drain still prejudiciously wet, from its discharging itself lower down over the surface of the ground. Thus, says the author mentioned above, it was the custom, until Mr. Elkington showed the absurdity of the practice, for drainers to begin to cut their trenches wherever the highest springs showed themselves between the *wet* and the *dry* ground, which not being of a depth sufficient to arrest and take away the whole of the water, others of a similar kind were under the necessity of being formed at different distances, to the very bottom of the declivity; which being afterwards in a great measure filled with loose stones, merely conveyed away portions of surface water, without touching the spring, the great or principal cause of the wetness. The effects of drains formed in this manner he asserts to be, that of rendering the surface of the land in some degree drier, so long as they continue to run with freedom; but as they are liable soon to be obstructed and filled up by sand or other materials, the water is often forced out in different places and directions, and thus renders the land equally wet, if not more so, than it was before. And it is likewise observed, that it is a more difficult task to drain the ground a second time in a proper method, from the natural appearance of it being so much changed, and the bursts of the old drains, as well as the greater difficulty of ascertaining the real situation of the springs.

It may sometimes happen, however, as where the highest are the strongest outlets, that they may be the main or leading springs; those which show themselves lower down in the land being merely formed by the water of the main spring overflowing, and finding itself a passage from an opening, or the porous nature of the materials of the soil near to the surface, and from being obstructed somewhat further down in the ground by some impervious stratum. This circumstance must, therefore, it is observed, be fully ascertained before the lines for the ditches or drains are marked out. In cases where the bank or rising ground is formed in an irregular manner, and from the erect nature of the situation, or the force of the water underneath, has been pushed down, the ditches made for the purpose of draining such lands should, it is remarked, always be carried up to a much higher level in the side of the elevated ground than that in which the water or wetness appears, as to the firm unchanged land; by which means the water of the spring may be cut off, and the ground be completely drained; which would not be the case if the trench or drain were formed on the line of the loose materials lower down where the water oozes out, which is liable to mislead the operator in forming the conducting trench, or that which is to convey the water from the cross-drain on the level of the spring to the outlet or opening by which it is discharged. But where the main or principal spring comes out of a perpendicular or very steep

bank, at a great height above the level of the outlet into which it may discharge itself by means of a drain, it will neither be necessary nor of any utility to form a deep trench, or make a covered drain, all the way from such outlet up to it, as from the steepness of the descent the water would be liable, when the drain was thus cut, from the thin strata of sand, and other loose materials, always found in such cases, to insinuate itself under the bricks, stones, or other substances of which the drain was formed, to undermine and force them up by the strength of the current, or, probably, in some instances, block the drain up by the loose sand or other matters, which may be forced away and carried down by it: in situations of this kind, it is observed that it is always the best way to begin just so far down the bank or declivity as, by cutting *in level*, the drain may be six or seven feet below the level of the spring, or such a depth as may be requisite to bring down the water to such a level as will be suitable to convey it away without its rising to the surface, and injuring the lands around it. The rest of the drain, whether it be made in a straight or oblique direction, need not be deep, and may, in many instances, be left quite open; it should, however, be carefully secured from the treading of cattle, and, where the land is under an arable system of cultivation, also from the plough. Where it is covered, the depth of about two feet may be sufficient. There will not, in such drains, be any necessity for the use of the auger in any part of them.

Where there is a difficulty in ascertaining the line of the spring, and consequently that of the cross-drain, either from its not showing itself on the surface, or from there not being any apparent outlet, it may, generally, be met with in carrying up the conducting drain for conveying away the water, which as soon as the operator discovers, he need not proceed any further, but form the cross-drain, on the level thus discovered, to such a distance on each side of the *tail*, or terminating part of the strata, of whatever sort, that contains the water, as the nature of the land, in regard to situation or other circumstances, may demand. Where, in forming a cross-drain, the line indicated by the spirit or other level is found to be in some places below that of the spring, and where, in boring in this direction, water is not found to follow, it will be necessary to make short drains or cuts of the same depth with the cross-drain from it quite up to the source of the spring; for, if the drain be cut below the line of the spring, the possibility of reaching it by means of an auger is lost, as where the under stratum is clay, and there is no under water, the use of the auger cannot be effectual; and if it be made above the line of the spring, it will be requisite to cut and bore much deeper, in order to reach it, the ground being in general higher in that part: besides, the portion of porous stratum below the drain may contain a sufficient quantity of water to render the land wet, and that may readily get down underneath the trench, between the holes formed by boring, and break out lower down. These circumstances are rendered more clear in fig. 3. which is the representation of the plan of draining where the banks are irregular; and fig. 4. shows the manner of cutting and managing the drains

in such cases; and fig. 5. is a side view or section of the sandy bank.

In situations where the extent of bog in the valley between two banks or eminences is so narrow and limited as that the stratum of rock, sand, or other materials that contain the water, may unite below the clay at such a depth as to be readily reached by the auger, it will seldom be necessary to have more than one trench up the middle, well perforated with holes by means of the auger; cross or branching drains being unnecessary in such cases. For notwithstanding the springs, that render the land injuriously wet in these cases, burst out of the banks or eminences on every side, for the most part nearly on the same level, the reservoir from which they proceed may be discovered in the middle of the valley, by penetrating with the auger through the layer of clay, that confines and forces the water to rise up and ooze out round the superior edge of it, where it forms an union with the high porous ground. From the drain being made in the hollowest part of the land, and the porous stratum containing the water being then bored into, it is obvious that, the ditch or drain thus formed being so much lower than the ordinary outlet of the springs, the pressure of water above that level, which is the bottom of the drain, must be such as to force that which is under the drain or trench through the holes made by the auger, and in many instances, until a considerable quantity of the water is evacuated, make it rise to a greater height than the level of its natural outlet. The effect of which must be, that the water forming the spring, having found by these means a fresh and more easy passage, will quickly relinquish its former openings, and thus be prevented from running over and injuring the ground, that previously lay lower down than it. This will be better understood by *fig.* 6. which explains the method of draining of such bogs. Where the bog has a descent from the side A A to the side B B, a drain cut on the side A A may be sufficient for the purpose. And fig. 7. is a front view of this drainage.

But in swamps or bogs that are extensive and very wet, other drains or cuts than such as convey off the springs must be made; as, notwithstanding the higher springs which chiefly cause the wetness may be intercepted, there may be lower veins of sand, gravel, or other porous materials, from which the water must likewise be drawn off. In cases of this nature, where the land is to be divided into inclosures, the ditches may be formed in such directions as to pass through and carry off collections of water of this kind, as well as those that may be retained in the hollows and depressions on the surface of the land. It is also further remarked in the practical work just mentioned, that there are in many places very extensive tracts of ground that are rendered wet, and become full of rushes and other coarse plants, from causes of such a nature as cannot be obviated by the making of either open or covered drains, however numerous they may be. Lands in this situation are frequently termed holms, and mostly lie on the sides of such rivers and brooks as, from the frequency of their changing and altering their courses between their opposite banks, leave depositions of sand, gravel, and other porous

materials, by which land is formed, that readily admits the water to filtrate and pass through it to the level of the last-formed channels, and which preserves it constantly in such a state of moisture and wetness, as to render it productive of nothing but rushes and other aquatic plants; and if a pit or ditch be made in lands under these circumstances, it quickly fills with water to the same level as that in the water-course. This effect is, however, more liable to be produced, as well as more complete, where the current of the water is slow, and its surface nearly equal with that of the land, than where its descent is rapid. Under such circumstances, while the river or brook remains at the ordinary height, no advantage can be gained, whatever number of drains be formed, or in whatever direction they may be made. The chief or only means of removing the wetness of land proceeding from this cause is, that of enlarging and sinking the bed of the stream, where it can be effected at a reasonable expense: where there is only one stream, and it is very winding or serpentine in its course, much may however be effected by cutting through the different points of land, and rendering the course more straight, and thereby less liable to obstruct the passage of the water. But in cases where there are more than one, that should always be made the channel of conveyance for draining the neighbouring land, which is the lowest in respect to situation and the most open and straight in its course. It may likewise, in particular instances, be advantageous to stop up and divert the waters of the others into such main channels, as by such means alone they may often be rendered deeper, and more free from obstruction: the materials removed from them may serve to embank and raise up the sides to a greater height, as while the water can rise higher than the outlets of the drains, and flow backwards into them, it must render the land as wet as it was before they were formed, and the expense of cutting them be thrown away.

In addition to the injury done by the water from the rivers in some situations, springs, it is observed, break out from the bottom of the more elevated banks, and are absorbed so as to filtrate through the materials of the soil above their levels. The wetness proceeding from these may be readily intercepted, or reduced to the level of the stream, by means of a drain. There are instances too, it is said, in which the wetness arises entirely from springs; as where the soil of the flat land between them and the river is not formed of loose sand or gravel, but of loam or a mixture of clay and loam. In such instances as these, the water proceeding from the springs is interrupted, and prevented from filtrating through the materials of the soil in its passage to the river, and thus forced up to the surface, over which it runs. In order to drain land in this situation, it is recommended that a trench should be commenced at the lower end of it, and brought from the river on the bottom of the bank whence the spring breaks forth. It ought likewise to be cut *below* the line of the springs, where it can be accomplished with greater facility, and kept open, in order to take the river water in time of floods, which would blow or break it up if it were covered, and likewise such runs of water from the more elevated grounds as may be pro-

duced by rains. Short covered drains must also be formed from this trench, a little distance into the bank, the bottoms of which should be higher than the level of that of the open one, in order to prevent any of the water contained in it from running back into them. Where the depth of this level does not reach the stratum that contains the water, in such cases the auger may also be employed to tap or let off the water of the springs. Cross-drains between the open cut and the river will not here be necessary, as the whole of the intercepted water will be conveyed along the bottom of the bank, and be discharged at a lower level into the river, except when the land is so extensive as to admit of being divided by cross-ditches into distinct inclosures. In these cases the open drain, on the upper side, may serve as a division between the meadow and the high grounds.

After being drained, land of this description is particularly well situated for watering, and the soil capable of being greatly improved by it, when proper modes are adopted.

Some attention is required, in the drainage of such lands, to the method of forming the drains, and the necessity of their being open or covered. Where the land is to be inclosed at the same time that it is drained, as the line of the trench may, in most cases, serve as a suitable division of it, there can be no doubt but that an open drain will be the most proper; but where there is not a necessity for inclosing the land, a covered one may be preferable. These points should in the first place be determined upon, and the depth, width, and other circumstances of the drain be regulated by them.

When the outlet, by which the water accumulated in the drain may be conveyed away has been fixed upon, which should generally be the nearest and the most convenient, a trench is directed to be brought up from it to the cross-drain that is to be formed all along on the line of the spring; an inclination of a few inches in every eight or ten yards being given for the purpose of permitting the water to pass away. When in cutting the drain that is to take off the spring, after getting through the clay, there happens to be a layer of firm gravel between it and the porous sand or other material that contains the water, the drain should be laid upon it, as being more solid; and to perforate the gravel with a punch, or dig small pits in it by the spade, in order that the water may rise up and pass off with ease and safety, in preference to that of the sand below; by laying it upon which, the depth and difficulty of constructing it would not only be greatly increased, but in different instances be incapable of being performed, from the level of the orifice not permitting its being cut to such a depth. In cutting the drain or trench on the tail of a rock, likewise, where such kind of stratum exists, if the level of the orifice will not allow of its being made so deep as to reach the rock, the clay or other impervious stratum that may lie immediately above must be bored through, that the water may flow up through the fissures or cracks in the stone, and likewise the auger holes, into the drain or passage; but where the level will permit of it, it is observed to be always more advisable to cut the drain through the clay, and so far into the rock below as may be sufficient for

supplying the necessary quantity of stones for constructing the drain or sough, as by means of the stone being thus broken the water will have a more free and easy exit. The expense of cutting the drain may by this be somewhat increased; but, probably, from its rendering the quarrying of stones in other places, and the carriage of them, unnecessary, will, in most instances, more than compensate such additions of expense.

Though, in the land to be drained, there may be an old ditch or water course in which it may be possible to tap or let off the spring by means of the auger, it may, notwithstanding, in most cases, be preferable to make a new trench or drain, in which the water of the spring only may be conveyed; and in situations where it is under the necessity of crossing such old ditches or channels for water, it must be well secured by means of *puddling* with clay, so as not to admit any surface water, which, from its sudden augmentation in case of floods, might quickly blow up, or break and destroy, the sough or drain.

As the water procured by tapping the springs in this way may frequently be made to serve different useful purposes, such as the irrigation of land, the turning of small mills, the supplying of houses, the filling of canals and ponds in pastures for the use of cattle, &c., the practice should be adopted with great care, in order to guard against the loss of water in one part of the drain by the same means that it may have been found in another, or by attempting to produce a larger supply; as by such means it may, in many cases, be let down from the wet retentive stratum on which it rests, into the dry porous one below, aud thus be completely lost.

When the drain is made through a soft boggy soil, and where it may have other water than that which rises from below passing into it, it will, it is said, be more proper to be open than closed, as the stones used in such drains are, from the softness of the foundation, soon found to give way and sink down, and the sough or drain liable to be filled up and destroyed. When the drain is covered, it is recommended to be made from three to four feet in width at the top, and from one and a half to two feet at the bottom, leaving in this way six or nine inches for each side stone, the same for the height, and six inches between for the conveyance of the water, constituting a square passage or sough. The level of the situation where the drain is to discharge itself, and the nature of the land through which it is to be made, must regulate the depth. The turf is then to be pared off thin and laid on one side, in order to be made use of afterwards; and the whole of the mould that may be dug up, thrown out on the other. The most difficult part of the business consists in laying the sough when in running sands; it being frequently requisite under such circumstances to have the side of the trench supported, and the loose sand prevented from falling down among the stones employed in constructing the drain, by means of flat boards and props, removed forwards as the work proceeds. When the sough or passage is laid with brick, small apertures should be left betwixt each, to allow the water to pass away from the sides of the drain, and the thin turfs are then recommended to be

placed over immediately upon the stones, without the intervention of any small loose stones, the grass side downwards, to keep the mould from escaping through the crevices. This is necessary, as the water principally proceeds from the bottom of the drain, but very little from the sides, and not the least from the top.

Turfs are also advised to be placed in the foundation of the drain underneath the sough in such quick loose sands, to prevent them from flowing up, and to render the bricks more secure in case of their giving way. In sands of this kind it is likewise a good way to dig just into the sides of the trench, from the line of the sough, where the auger is to be employed; and when this has been done, to cover the places in the same way as the sough; as by this means the sand thrown up by the spring may be readily removed, till such times as the force of the spring abates, and it is free from the main current passing in the middle of the drain. At fig. 1. in plate LXXIV, is shown the manner of digging into the sides of the drains where soughs are laid in these cases, and the auger employed, as the holes in this way are less interrupted by the currents. And fig. 2. is a section, showing the manner of laying the sough and covering it.

In the same plate a plan is also given at fig. 3. of Mr. Elkington's method of accomplishing the purpose of draining in low swampy lands on the sides of rivers; in which the advantages that may be gained, in some cases, by irrigation are likewise shown. And fig. 4. shows the manner of draining where the water is dammed up as a mill-head, being a trough several feet longer than the width of the dam on each side, as seen by A and B in the plan. It is secured by stakes driven into the earth on each side with cross bars above, as represented in the figure. The space between the top of it and bottom of head is to be well rammed with clay. A cut is also necessary on bank of head, for securing the water.

The portion of sough above the holes made by the auger, is recommended to be left open, till such times as the sand is brought up, and the openings are become perfectly free; but until this happens, the sand should be constantly removed. Afterwards the sough may be covered up with the greatest safety. An opening, or kind of funnel, is likewise advised to be constructed above some of the holes formed by the auger, or at some other convenient part of the drain, up to the surface, for the purpose of occasionally inspecting it, and seeing that it is open and clear, and whether the run of water increases or is diminished. When the holes made by boring are not sufficient for discharging or letting off the full quantity of water that the spring can emit, and when the stratum containing the water is near to the bottom of the trench, and there is a bed of hard gravel between, which cannot be easily penetrated by the boring instrument, holes or openings are recommended to be dug down to the spring by the spade, and afterwards filled up with small loose stones, a round stake or piece of wood being previously put down in the middle and withdrawn when the stones have been filled in, in order that a good opening for the water to flow up may be provided. If no other water but what comes from the drain be admitted, there will, it is observed, be no danger in such cases of the holes formed by the boring

instrument being filled up, whether it be in an open or covered state, as such is mostly the force of the water issuing through them, that it can easily remove those portions of earth or mud that may have been accidentally washed into it; the drains can therefore, of course, only be damaged by the flowing in of much surface or flood water upon a sudden.

In respect to the materials employed for the construction of drains of this kind, stones are certainly the best where they can be procured at a sufficiently reasonable rate. Bricks may likewise be made use of where stones cannot be had; of which there are several different kinds invented for the purpose, besides those of the ordinary sort:—as may be seen in the plate on *Draining bricks*, at figs. 1, 2, 3. Where small drains are only wanted, as in conducting water for domestic uses, a brick excavated in such a manner as to form a kind of small arch may probably be made use of with most advantage. But in cases where larger drains become necessary, a more solid kind, which are formed for the purpose in different shapes, may be employed with greater success. A sort has lately been formed in Warwickshire, that has been much employed in the construction of such drains. In making use of bricks of this description, they are laid singly, without having a reversed one underneath; as when that is the case, it has been found that the water passing on the under one is apt to produce a sort of earthy incrustation, which in the course of a few years becomes so great as in some measure to block up the passage of the water, and thus render the drain useless. Where the foundation is of a clayey nature, they may always be safely laid without having any thing underneath them; but where it is of a soft sandy kind, a common brick may be laid under each side to retard their sinking down, and so placed as to form a regular arch that may resist the pressure from above. They are capable of being constructed of the same shape to any size, according to the dimensions of the drain or the quantity of water it may convey. Though the earth that has been dug out of the drain in these cases, when filled into it again, may at first appear considerably higher than the common surface of the land on the sides, it should be let remain in that state, as in a little while it generally sinks to the proper level: but when made exactly level at first, from the earth's gradually sinking down hollows are formed that afford lodgments for water, which by sinking through may injure the drains.

In very wet peat grounds, during the time the drain is forming, the water from the surface, or that which may trickle from the sides, before reaching the main body of water, should be stopped occasionally; and when let off into the sough, a turf must be placed so as to prevent any soft earthy matter that may be forced down with it from passing through, as injury may be done by it. If such trees as have spreading roots happen to be in the line of the drain, they ought to be completely grubbed up; as, if this be not done, the fibres of the roots, by extending themselves through the joints and crevices of the stones, are apt to get into the drain, and quickly put a stop to the passage of the water in it.

In cases where the water issuing from drains is tinged of a red

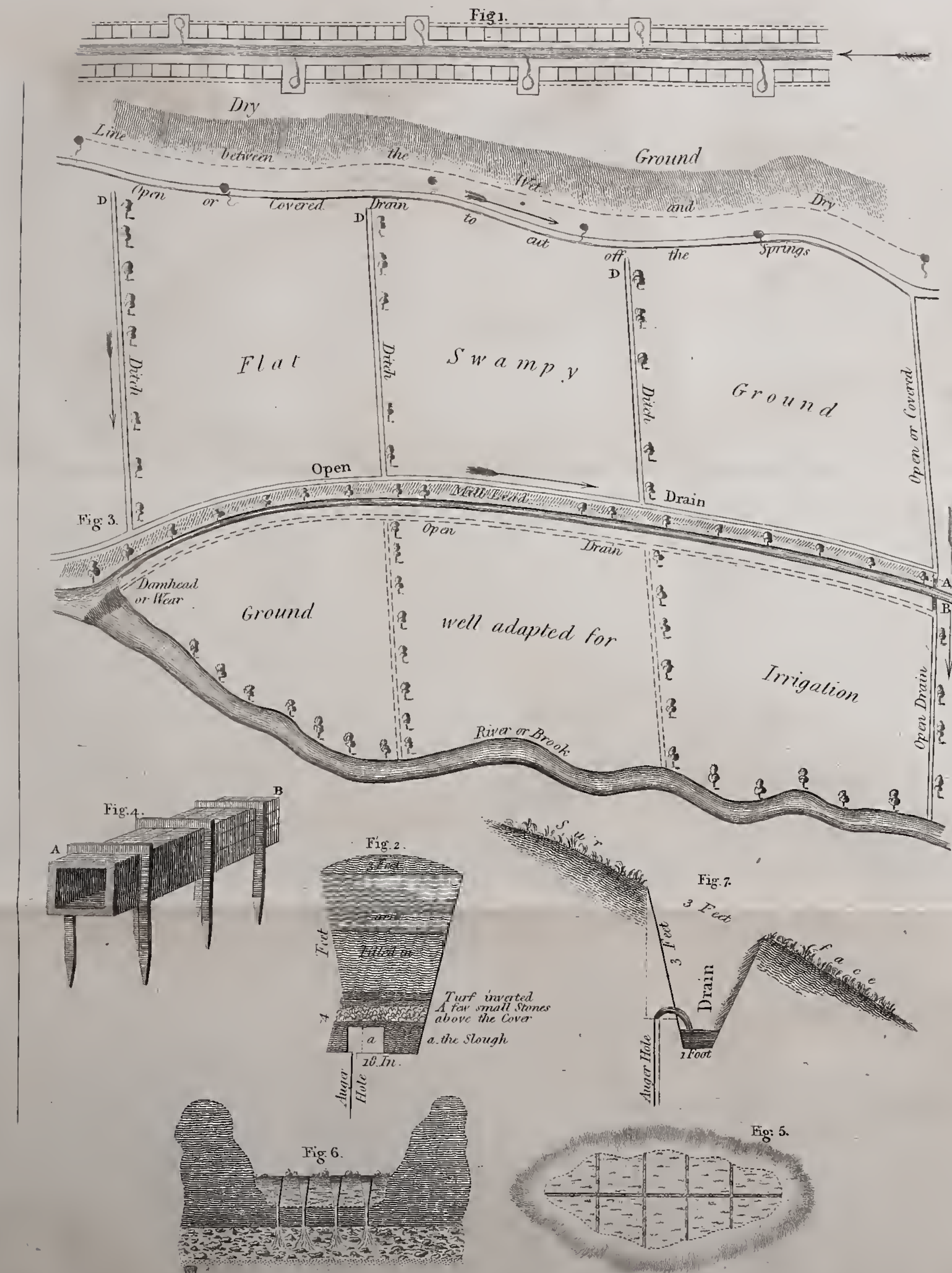
ochry colour, it is a sign that there is a stagnation proceeding from some cause or other, as that which has been just mentioned when the drain has been laid amongst trees, or from the breaking in of some part of the sough, which should always be attended to, and removed or repaired as speedily as possible, that the ground may not become again injured by wetness. In order to complete the business in all these cases, the opening or mouth of the drain should be carefully guarded by some means or other, such as a railing, from being poached, or forced in, and choked up by the treading of cattle in their attempts to drink at it; and where injuries have occurred in this way, they should always be speedily removed. The circumstances which first afford evidence of the efficacy of the drain, and which speedily become obvious when the spring or reservoir of water has been properly drawn off, are, that all such surface drains as may have been formerly made, and the neighbouring pits, ditches, and other hollow places to which the water may have been dammed up, become suddenly dry, and afterwards continue in that state.

Methods of Draining Boggy Lands by perforating the retentive Substratum.—There are large tracts of boggy waste land in different districts of the kingdom that cannot be brought into a state of cultivation, from a wetness which does not originate from springs immediately beneath the surface, or the overflowings of any in the neighbouring high grounds, but from the collected rain water becoming stagnant on a retentive body of clay, or some other impervious material, through which the water cannot sink; and, being likewise encircled with higher ground composed of the same impervious substances, the water of itself can have no outlet of the natural kind: when such lands become soft and spongy, they frequently form bogs of a very confined kind. And as such bogs are often situated very greatly below the ground that surrounds them, the opening of a small drain, or conductor, to convey off the water collected by smaller drains, would be attended, in many instances, with an expense greater than could be compensated by the land after it had been drained. The thickness of the impervious stratum that retains and keeps up the water in such cases is often so great, that though the stratum below be of a porous and open nature, such as sand, rock, or gravel, the water cannot of itself penetrate or find a passage from the one into the other; consequently, by its continued stagnation above, all the different coarse vegetable productions that have for a great length of time been produced on its surface, and probably the upper part of the soil itself, are formed into a mass or body of peat earth, equally soft and less productive than that of any bog originating from water confined below, and which is only capable of sustaining the weight of cattle in very dry seasons, when the wind and sun have exhaled and dried up a great part of its surface moisture; but even then it is incapable of admitting the plough upon it.

As the cause of these kinds of bogs is materially different from that of those which have been already noticed, their drainage must of course be accomplished in a different way. The following method of proceeding is recommended as perhaps the least expensive. In

the middle, or most depending part of the ground, the first drain may be cut, into which all the others should be made to lead; the number and direction of which must be regulated by the extent of the bog. They should be cut through the peat, or moist spongy upper soil, to the surface of the clay, or other retentive stratum of materials, which must then be perforated in order to let the water down into the pervious stratum below, by which it may be absorbed and taken up. The same effect might be produced by forming one large well, or pit, in the middle or lowest part of the bog, by digging through into the porous stratum below, and connecting the other drains with it, as by such a method the trouble and expense of boring along the drains would be saved. In these cases, when drains are made, they should always be cut as narrow as it is possible to make them, and, after the holes have been formed in them by boring, filled up with loose stones to within about a foot and a half of the surface, which space may be made up by a portion of the earth that had been taken out, putting a turf the green side to the stones before the earth is thrown in. By this means the water and prejudicial moisture of the peat, or upper soil, may be taken away by the drains, and pass off through the holes that have been formed in their bottoms. But where pits are employed, these should only be filled with small stones to the level of the bottom of the drain, the filling being performed as soon as possible after they are formed; where there is a chalky stratum below, after taking it out, the flints contained in it may be made use of in this way with much advantage: and where the drains can be carried into quarries, where the stone is much fissured, nothing more will be necessary. Where land of this sort is afterwards to be ploughed, great attention should be giving to the forming of the ridges and giving them a regular descent towards the main drain, which will contribute greatly to the assistance of the others in conveying off heavy falls of rain water when they occur. But previous to any attempt to drain lands of this kind in the way that has been described, it is recommended as proper to ascertain whether the porous stratum under the clay be dry, and capable of receiving the water when let down into it; or already so loaded with moisture itself, as, instead of receiving more from above, to force up a large quantity to the surface, and thus increase the evil it was intended to remove. This may be the case in many instances, and the substratum contain water which affords no appearances of wetness on the surface, at the place, on account of the compact body of clay that is placed over it, but which, from its being connected with some spring that is higher, may flow up when an opening or passage is given it either by means of a pit or the auger. In this way a greater quantity of water might be brought to the surfaces which, from its being confined by the surrounding banks, would render the ground much more wet than before, and in particular situations produce very great degrees of wetness. When the surrounding high ground declines lower than the bog, though it may be at a considerable distance, by the aid of the level, and the appearance of the surface, the nature of the stratum underneath may, it is observed, in some degree, be ascertained; and, notwithstand-

DRAINAGE OF LOW SWAMPY LANDS.



ing it may already contain water, a drain may be formed into it to carry off that water, and what may likewise be let down into it from the retentive stratum that lies above it;—as is seen at fig. 5. in plate LXXIV. which exhibits the plan of drainage in these cases, as recommended by Mr. Elkington, in boggy or spots of marshy land injured by stagnant moisture, but where springs do not exist. And fig. 6. is a front view or section of this drainage: ABCD here, as in the plan, represents the drains cut through the boggy earth, and filled up to within a foot and a half of the top with loose stones: EFGH shows the perforations of the auger through the clayey stratum, and the descent of the water into the rocky or porous stratum below: K, the place where a cut should be made for draining off the water where the land declines sufficiently, and the porous substratum is saturated with it so as to throw it on the surface through the perforations.

Methods of Draining Hilly Lands.—The draining of hills and elevated pasture lands has hitherto been but little attended to, though the herbage which is produced by the wetness of them from such inattention is, probably, the principal cause of a disease extremely fatal to some of the animals which they support.

Draining in situations of this kind is not, in general, attended with great expense, as the drains need seldom be covered or filled up, only in such places as may be sufficient for passages for the animals to cross by. And though, where the depth of the trench does not come to the water confined below, it may be necessary to perforate lower, there need not be any fear that the holes will fill up, even where the drain is left open; as the impetuosity of the water itself, as has been seen, will remove any sand or mud that may fall into them, where much flood or surface water does not get in: small openings may, however, be made along the upper side of the trench, in order the more effectually to secure them against any obstructions; and in these the perforations may be made, leaving the mouth of the holes about six inches higher than the bottom of the drain, which will be without the reach of the water that may be collected during the time of heavy rains. This may, however, be better understood by the representation in plate LXXIV. in which fig. 7. shows the manner of forming the auger holes so as to be higher than the bottom of the drains.

The sides or declivities of many hills, from the irregularity of the disposition of the strata that compose them, are often covered with alternate portions or patches of wet and dry ground. By the general appearance of the surface and the vegetable products that are grown upon it, the nature and direction of the internal strata may, as has been already observed, frequently be ascertained with so much certainty as to determine the line or direction of a drain without the necessity of examining below the surface of the land. As the ease or difficulty of draining such grounds depends solely on the position of the different strata of which the hill or elevation may be formed, and upon the erect or slanting direction of the rock, or other retentive body in which the water is contained; where the rock has a slanting or horizontal inclination, the whole of the different springs

or outlets, that show themselves on the surface, may originate from or be connected with the same collection or body of water, and may be all drained and dried up by cutting off, or letting out, the main body of water, by which they are supplied, at the inferior part of the reservoir, or that part where the water would of its own accord readily run off if it were not confined beneath an impervious covering of clay or some other material.

But in cases where the rock lies in an erect or perpendicular form, and contains only partial collections of water, in some of the more open cracks or fissures of the stone, that discharge themselves at various openings, or outlets, that have not the least connection with each other, it would be an idle and fruitless endeavour to attempt the cutting of them off by means of one drain, or by boring into any of them in particular, without cutting a drain into each, as is shown in plate XLII. at fig. 3. In this case it is more advisable to make the main drain wholly in the clay, with small cuts made up to each outlet, than along the place where the springs burst out; as in that line of direction it would be too greatly in the rock, and consequently be extremely difficult to cut, on account of the nature and disposition of the stone: when the water passing out on the line of the springs can be found by the auger in the main drain, at the point where it joins it, it will, it is observed, be the more completely cut off; but where this is not practicable, the depth of the small cuts may reduce it to such a level as will prevent its flowing over and injuring the surface of the land below it.

In such hills as are constituted of alternate strata of rock, sand, and clay, the surface of the latter may frequently be wet and swampy, while that of the former is dry, and capable of producing good crops of grass; in all such cases, in order to drain the land completely, as many cuts will be necessary as there may happen divisions of wet and dry soil: the summit, or most elevated part of such hills, being mostly formed of loose porous materials, through which the rain and other water descends, till its passage becomes obstructed by some impervious bed or stratum, such as clay, when it is forced up to the surface, and runs or oozes over the obstructing stratum; and after having overflowed, the upper clay surface is immediately absorbed and taken up by the succeeding porous one, and, sinking into it in the same way as before, passes out again at the lower side of it, and renders the surface of the next clayey bed prejudicially wet as it had done in the first. In this way the same spring may affect all the other strata of the same kind of which the hill consists, from the highest part down the whole of the declivity, and produce in the bason, or hollow at the bottom, a lake or bog, should there not happen to be a passage or opening to take away the water. In order effectually to drain hills of this kind, it is remarked, that it will be the most advisable to begin by forming a trench along the upper side of the uppermost rushy soil, by which means the highest spring may be cut off; but as the rain and other water that may come upon the next portion of porous soil may sink down through it to the lowest part, and produce another spring, a second cut must be made in that part to prevent the water from

PL: LXXV. 8°

DRAINAGE of LANDS

where the soils are porous above and retentive below.

Fig. 6.

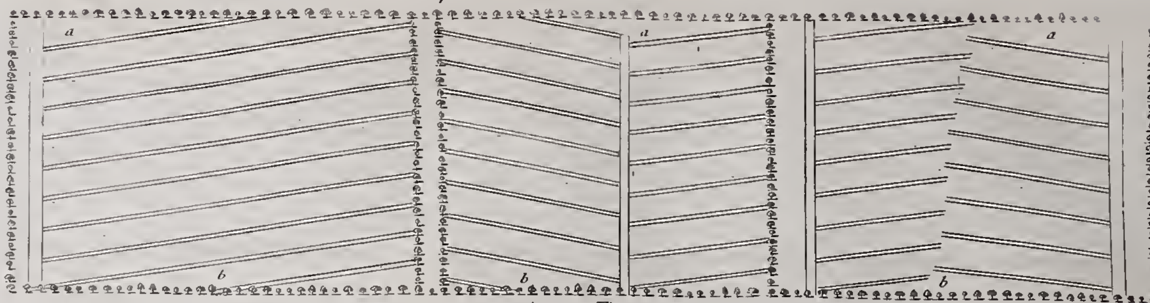


Fig. 7.

Fig. 8.

Fig. 1.

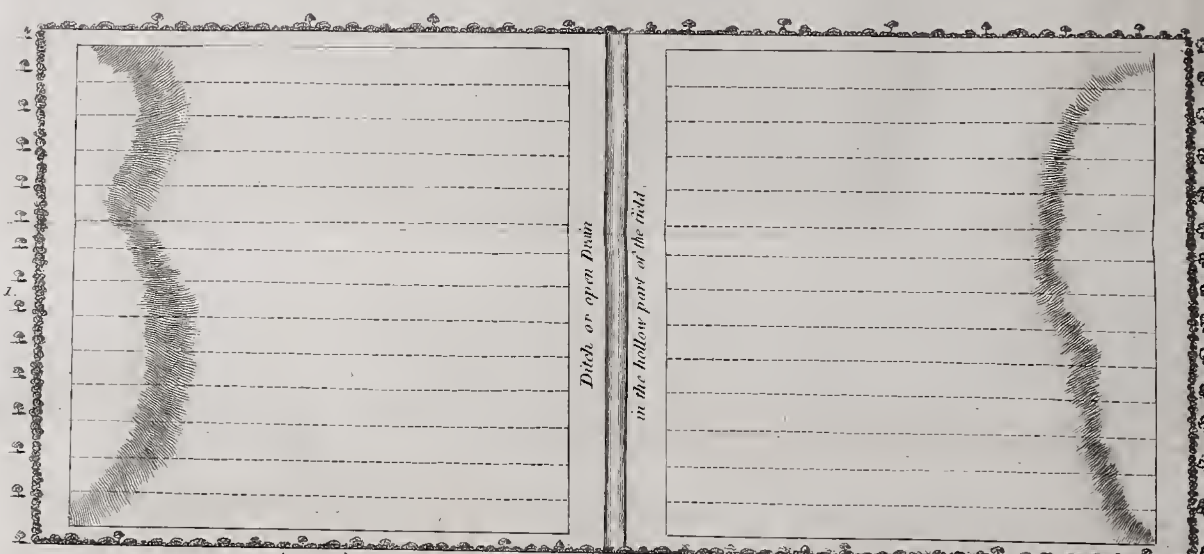


Fig. 2.

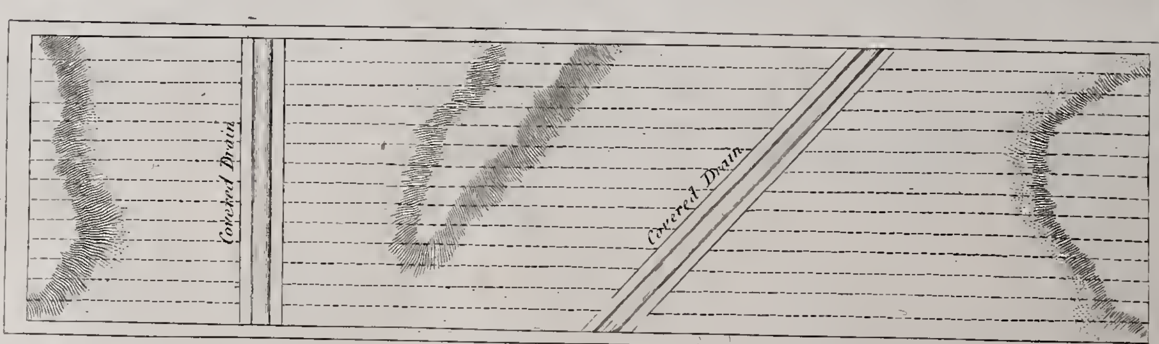


Fig. 3.

Ditch or open Drain.

Fig. 4.

affecting the surface of the succeeding clayey bed. And similar cuts must be formed so far down the declivity as the same springs continue in the same way to injure the land, and in some cases a sufficiency of water may probably be obtained to irrigate the land below, or some other useful purpose.

It sometimes happens, however, that the strata of which hills are composed are disposed with such regularity, as has been already shown, that the water contained in them may be capable of being taken away from either side on the same level, a circumstance which might be in some cases advantageously applied in draining one side, and watering the other; as there is frequently on one side wet swampy ground, while on the other it is much too dry for the purposes of healthy vegetation. This often arises from the retentive body of clay that keeps up the water not being disposed in a horizontal or slanting direction, but having a dip or depression more to one side than the other, and from the dry side being overlapped by a stratum or covering of clay, on which account the water is under the necessity of issuing at the open side: but when a passage is afforded it on the dry side, by a drain or trench lower than that by which it passes off on the wet side, the course of the water below may be changed without much difficulty. From the opposite side being porous and sandy, it becomes a reservoir for the reception of the rain water, which afterwards discharges itself through the opening formed in the clay; a circumstance which may be of much utility in furnishing water for domestic uses, in cases where the situation, in respect to the hill, will admit of it, and thus render the additional expense of conveying it by other means unnecessary. Where a reservoir of water is confined in a low situation contiguous to higher land, it may often be raised so as to supply houses, or be otherwise useful, notwithstanding it is much below that level, by confining it in a pipe or narrow brick opening; for the reservoir or collection of water whence the spring or outlet of water is furnished being pent up, and confined between two impervious strata, and the higher part of it extending probably in many cases to a great height and distance in the elevated ground, it is plain that if a hole, or perforation, be made through the superincumbent stratum into the lowest part of the porous bed containing the water, it may be raised, by being confined, nearly as high as the level of the head of the reservoir, or collection of water. In conducting drains for such purposes as these it will, however, always be necessary to be cautious not to cut or bore in them so deep as to reach a porous stratum, as by that means the water that had been found in one situation might be thus let down and lost in another. These different cases of draining may be better understood by consulting plate LXXV. in which fig. 1. represents the plan of Mr. Elkington's method of draining in a hill where the soil is composed of alternate beds of rock and clay. Fig. 2. is side view or section of the same, which explains the situation of the strata and the places for cutting the drains. And fig. 3. shows the nature of the drains; the main drain to be formed wholly in the clay, and drains cut into each of the fissures between the rocks when the water is contained there: AAAAA, points in the main

drain, where attempts may be made to effectually intercept the water issuing along the dotted line above it by boring, instead of its being reduced by the small cut, so as to produce no injury on the surface of the land below. Fig. 4. is a view or section of the hill to be drained, and the mode in which water may, from the irregularity of the retentive strata, be drawn off on the dry side for domestic uses. Fig. 5. represents the mode of raising the water to a level of the head of the reservoir in low situations by confining it in a narrow pipe or chimney of brick.

The possibility of raising water in particular situations by different methods of this nature has been fully shown in various instances, in digging wells and pits to great depths.

Methods of Draining Mixed Soils.—Where the soil is of a mixed and varied nature, but the most prevailing parts of the clayey kind, the business of draining is considerably more tedious and difficult than where the superficial and internal parts have greater regularity.

In such sorts of lands, as all the different collections of water are perfectly distinct from each other, by means of the beds of clay that separate them, each collection becomes so much increased, or accumulated, in the time of heavy rains, that they are filled quite to the level of the surface of the clay by which they are surrounded; when the water getting a free passage, as it would over the edges of a bowl or dish, overflows and saturates the surface of that bed of clay in such a manner as to render it so perfectly wet and sour, that its produce becomes not only annually more and more scanty, but the soil itself more steril and unproductive.

From the sand beds in such cases having no communication with each other, it must evidently require as many drains as there are beds of this kind, in order fully to draw off the water from each of them. A drain or trench is therefore recommended to be cut from the nearest and lowest part of the field intended to be drained, up to the highest and most distant sand bank, in such a line of direction as, if possible, to pass through some of the intermediate sand beds, and prevent the labour and expense of making longer cuts on the sides, which would otherwise be requisite; but where many awkward turnings in the main trench would be the consequence of this, and would lengthen it, and where by passing across the beds in parts higher than the surface of the clay which surrounds them, it would greatly increase its depth, and be worked with difficulty, especially when rock or running sand drains, made somewhat in the shape of a Y, should branch off to the different beds, in order to take off the water they may contain, and convey it into the principle one, as shown in plate LXXV.; in which, at fig. 6., is represented Mr. Elkington's method of drainage in such cases. The form of cutting, so as to remove the wetness from the different reservoirs, is fully shown. In some cases this wetness may proceed from springs higher up, and passing over the upper soil through the sand beds, by not being permitted to descend lower than the retentive bed of clay. In these situations the drainage may be effected with facility, after a conducting main drain from the outlet has been formed, by making an upper drain to intercept the water coming from the chief springs, as ex-

plained by Mr. Johnstone in the new edition of his Account of the Modes of Draining Land.

But notwithstanding the sand beds let the water they contain out on every side, in such a way as to injure the clayey surface quite round them, it is further observed, that a drain made one side may be sufficient to completely draw off the water from the whole, and hinder it from bursting out at either side, if the place where it is cut be the lowest or most depending. But unless the drain be so cut it cannot possibly have this effect, while the water can meet with a passage on the contrary side of the bank lower than the bottom of the drain. This circumstance must, therefore, in the first place be attended to; and by a careful examination of the ground, and the application of the level, the most proper side and situation for the drain may be readily ascertained. And when the water breaking out round the bank has been seen in dry seasons to run at one part and not at the others, it is a sign that that is the lowest point, and that by cutting the drain on the line of that level, the water may afterwards be prevented from rising so high as the upper outlets, or above the level of the bottom of the drain, even in the most wet times of the year. But, besides the lands constituted in this way, there are others that have much similarity, only the different beds are of less extent, and lie together with greater regularity, in consequence of which they can be drained in a more easy manner with less cutting, and of course of less expense. Below the layers or beds of sand and clay that lie, in this manner, alternately together, and nearly parallel to each other, is, generally, it is remarked, a body of impervious clay, which keeps up the water that is contained in the sand, and which being constantly full, renders the adjacent clay moist, and in wet seasons runs or trickles over it. As in these cases the principle under-stratum of clay is rarely above four or five feet below the surface, a drain is advised to be cut to that depth through the middle of the field, if it have a descent from both sides; but if it decline all to one side, the drain must be made in that place, as the water will more readily discharge itself into it; and, unless the field be of great extent, and have more depressions or hollows in it than one, one drain may be quite sufficient for the purpose, as by crossing the different beds that retain the water it must take it off from each of them;—as may be seen in plate LXXV.; in which fig. 7. shows the method of draining where the land or field is hollow, and only requires one principal drain to be cut towards the middle. And fig. 8. explains other cases of this nature, where, from the distribution of the strata, other drains become necessary in a sloping direction across the declivities.

A principal difficulty in draining ground of this nature, and which renders it impracticable by one drain, is when the direction of the alternate layers, or beds of clay and sand, lie across the declivity of the land, so that one drain can be of no other service than that of conveying away the water after it has passed over the different strata, and would naturally stagnate in the lowest part of the field if there was no other passage for it. Where the land lies in this way, which is frequently the case, it will, therefore, it is remarked, be necessary, besides the drain in the lowest part, to have others cut up from it in

a slanting direction across the declivity, which by crossing all the different veins or narrow strata of sand, may be capable of drawing the water from each of them ;—as shown in the plate.

In the draining of mixed soils of this kind, it will always be first necessary to ascertain with accuracy the inclination of the alternating strata, or the position of them, in respect to the field to be drained, as this must in a great measure guide the direction of the drains. In drains under these circumstances there is rarely any necessity for perforating the bed below, as the required depth of the trench is fully sufficient, and as there is either no reservoir of water, which from the want of connection with higher land can rise up through the perforations, or it is at such a depth, and under such a body of clay, that it cannot be injurious to the surface ground.

In these cases it is recommended that the drains, after being formed at the bottom in the manner of a sough, or set in the way of a triangle, be filled some way up by small stones, tough sods being applied green side downwards upon them before the mould is filled in. But where stones cannot be readily procured, faggots may be employed in their place where they are plentiful: the under part of the drain being laid, or coupled with stones, so as to form a channel or passage for the conveyance of the water that may sink through the faggots, and for the purpose of rendering them more durable; as where the water cannot get freely off, which is generally the case where there is not an open passage made of some solid material, it must, by its stagnation, soon destroy the faggots, and choke up the drain. In fully accomplishing the drainage of such kinds of soils as these, attention should always be paid, where the land is much on the descent, to mark out the branching drains in a sufficiently horizontal direction, so that the fall may not be too rapid, by which the bottom of the trench may be rendered uneven, and the passage of the water be thus impeded, which might soon force them up and make them useless; but the fall should, however, be so much as that the water may fully clear its way. The circumstance that renders fewer drains necessary in such lands as have a horizontal position, is, that the water is brought equally from the sides of them; while those on a sloping direction only draw from the upper side of the drains and consequently require them to be more numerous and closer to each other. Indeed, in all situations where surface draining is to be had recourse to, this is the case; but it is more particularly so in such sorts of grounds as have a retentive substratum on which the porous surface materials are deposited.

Soils constituted of beds of clay and sand, in the manner that has been just described, are sometimes characterised and known in places where they are very prevalent, as in some parts of Lancashire, by such terms as have a relation to the circumstance of their holding water in the way that some kinds of vessels do*. Sometimes, too, the water is found to be retained in small beds of solid rock, that are crossed and intercepted by beds of clay.

Methods of Draining Retentive Soils.—The practical mode of drainage in such soils as are composed of porous materials above, and

* *Sand-pots* or *gut.*

such as are retentive below, or the contrary, is materially different from that which has been described above. Many tracts of level land are injured by the stagnation of a superabundant quantity of water in the upper parts of the surface materials, which does not rise up into them from any reservoirs or springs below. The removal of the wetness in these cases may, for the most part, be effected without any very heavy expense. From the upper or surface soil in such cases being constituted of a loose porous stratum of materials, to the depth of from two to four or five feet, which has a stiff retentive body of clay underneath it, any water that may come upon the surface from heavy rains, or other causes, readily filtrates and sinks down through it, until it reaches the obstructing body of clay which prevents it from proceeding; the consequence of which is, that the porous open soil above is so filled and saturated with water, as to be of little utility for the purpose of producing crops of either grain or grass. Land situated in this way is frequently said to be wet-bottomed by farmers. In order to remove this kind of wetness, it seldom requires more than a few drains, made according to the situation and extent of the field, of such a depth as to pass a few inches into the clay, between which and the under surface of the porous earth above there will obviously be the greatest stagnation, and consequently collection of water, especially where it does not become much visible on the surface. In these cases there is not any necessity for having recourse to the use of the boring instrument, as there is no water to be discharged from below.

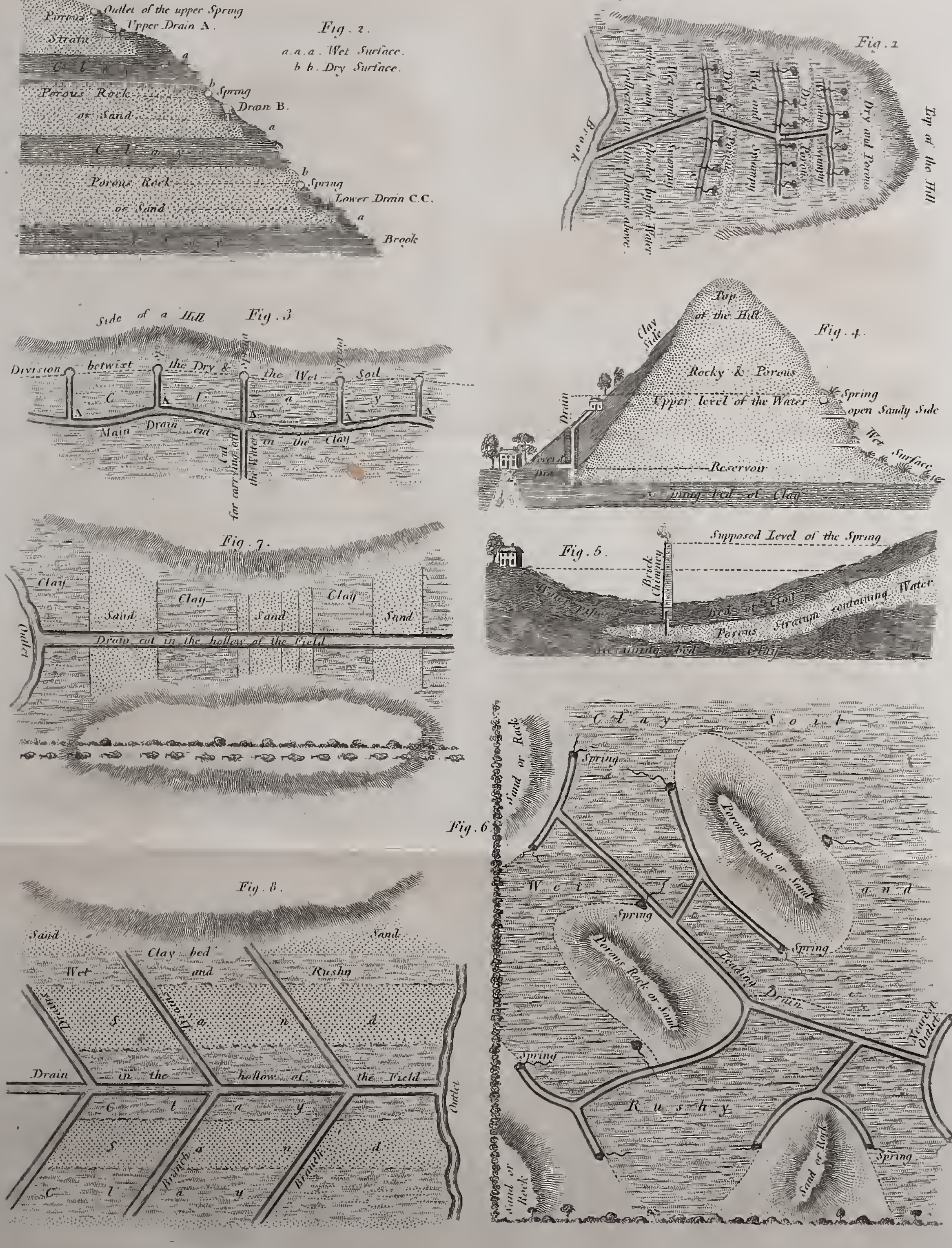
When the field to be drained has only a slight declination, or slope, from the sides towards the middle, one drain cut through the porous superficial materials into the clay, in the lowest part of the ground, may be sufficient to bring off the whole of the water detained in the porous soil. This effect may likewise be greatly promoted by laying out and forming the ridges so as to accord with the direction of the land, and by the use of the plough or spade in removing obstructions, and deepening the furrows; but which may be better understood by the annexed plate at fig. 1. In such situations, where the drain has been formed in this manner, the water will flow into it through the porous surface materials, it is observed as well as if a number of small trenches were cut to it from each side, as is the practice in Essex and some other parts of the country; but which is evidently an useless and unnecessary labour and expense; and, besides, the field is greatly injured by so much cutting. The drain made in the hollow may frequently serve as a division of the field, in which case it may be open; but in other circumstances it may be more proper to have it covered.

Where a field of this description has more than one hollow in its surface, it is remarked, that it will obviously be requisite to have more than one main drain; but when it is nearly level, or only inclines slightly to one side, a trench or drain along the lowest part, and the ridges and furrows formed accordingly, may be sufficient for effecting its drainage:—as may be seen in the plate at fig. 2. There may, however, be cases, as where a field is large and very flat, in which some side cuts from the principal drain may be necessary, which must

be made a little into the clay, and as narrow as they can be wrought, and then filled up with stones or other suitable materials, in the manner that will be presently described. These points may be better understood by plate LXXVI.; in which fig. 1. represents the plan of draining followed by Mr. Elkington where the soil is porous on the surface and retentive underneath, and where the ground declines towards the middle where the drain is made, the ridges being formed so as to answer the declivity. Figs. 2. and 3. explain the method of forming the drains where the grounds have more than one depression, or are nearly level, or incline a little to one side; and fig. 4. is a view or section of the above. At fig. 5. is shown the Essex method of draining in ploughed springy lands, where the surface soil is tenacious, as described by Mr. Kent. Main declination of the land from *a* to *b*. Fig. 6. represents a field drained by means of one of its ditches in the room of a chief drain. Fig. 7. is a field drained by a principal drain in the middle, declining more at that part than the sides. And fig. 8. is a field drained by two outside principal drains, the land being higher in the middle than on the sides.

But though these are the plans that are to be pursued in draining soils where the porous body is upon the surface, there are other more extensive cases, but in which the soil is formed in a directly opposite manner, the clay substance constituting the surface, and the porous body being underneath. In general lands of this nature lie extremely flat, and without the least declivity, by which the injurious stagnant water on the clay surface can possibly get off, without the assistance of drains being formed for the purpose; but in soils of the same sort where the situation is more of a declivity, there is rarely any bad effects from the same cause. Soils of this nature are, however, drained with greater difficulty, and require a much greater number of trenches or cuts, than those of any other kind, as they must be marked out and disposed in such a way as to collect and convey the water every-where from the surface; as it can only force itself off into them from above, being prevented from sinking in through the clay, as in those soils of a contrary kind. Where there happens to be hollows or irregularities in the surface of the land, water may often be observed to continue standing in them, at the distance of but a few feet from the drain. In draining such lands, it will, it is observed, always be necessary, in the first place, to make a large or conducting drain at the lowest part, or the end of the field, for the purpose of receiving and conveying away the water collected by the less collateral cuts which it may be necessary to make on each side of it. Where it suits for the purpose of dividing the land, this principal drain may be better to remain open than be covered, as by that means the months on outlets of the different small drains that come into it may be conveniently examined, and cleared out when necessary. In such soils too, when they are under tillage, the construction of the ridges, so as that they may accord with the declivity, is a matter that must be carefully kept in view. They should in all such cases have also that degree of elevation or roundness in the middle that may be sufficient to afford the water ready fall into the furrows, which should likewise have such a depth and fall as may take it

DRAINAGE OF HILLY LANDS & MIXED SOILS.



quickly into the drains. The ridges, besides being well laid up, should have small open drains formed in a slanting direction across them, in such a manner as to form communications with one another, and with the furrows.

Various plans of drainage in such cases are recommended by Mr. Marshall, in his valuable work on Landed Property.

By the above means, therefore, a large portion of the rain water might be conveyed off as it falls, and the number of small cuts that would otherwise be required be much diminished. The drains, when necessary, should also be cut as narrow as possible, and be filled up with small stones in the way that has been noticed; and the bottom or sough of the principal or conducting drain, where it is not an open one, should be formed with a small channel or conduit at the bottom, in the way that has been mentioned, in order to facilitate the passage of the water. It is the best method too to form the small drains by what is termed *coupling:* that is, placing the stones in the bottom in an inclining direction on one another, so as to form a sort of a triangular opening of from four to six inches underneath. From the water being wholly brought in from the top of the drains, it is requisite that they be filled with small stones up to such a distance from the surface as will just admit the plough or harrow to pass over without disturbing them, which space should be covered in with loose gravel. Where such gravel can be readily procured, it is always to be preferred to the tenacious clayey earth that came out of the trench, from its more readily admitting the water to filtrate and pass through it into the stones. A thin coat or layer of straw or rushes, or, what is still better where the land is in a state of pasture, the surface turf pared thinly off, must be applied over the stones, in order to guard against the smaller parts of the gravel from insinuating themselves and filling up the openings between them. This is not, however, so necessary to be done when gravel is used, as when mould is the material made use of.

This method of removing water from land is, it is observed, suited to every tenacious clay soil, whether it be porous or not below; but in many cases deepening the furrows, with very few drains, might prove sufficient for remedying the injury, where the retentive upper soil is only of the depth of a foot or two, with an open or porous material beneath it, through which the water could readily sink downwards, and be discharged again at some lower part of the field. The drains and furrows ought consequently to be deepened quite through the clay into the porous soil, in order to fully expedite the descent and discharge of the water.

Much may likewise be effected in many cases of clayey soils, both of the deep and thin kinds, by breaking and opening them well up, to such depths as may allow the water to sink down to such a distance as will render it not prejudicial to the crops that may be cultivated upon them; and by the incorporating of dung and calcareous manures with them in large proportions, as may be seen by the effects of deep trenching in the business of gardening. This should be performed by such implements as operate deeply, without turning the mellow surface mould down underneath. When hollow drains are

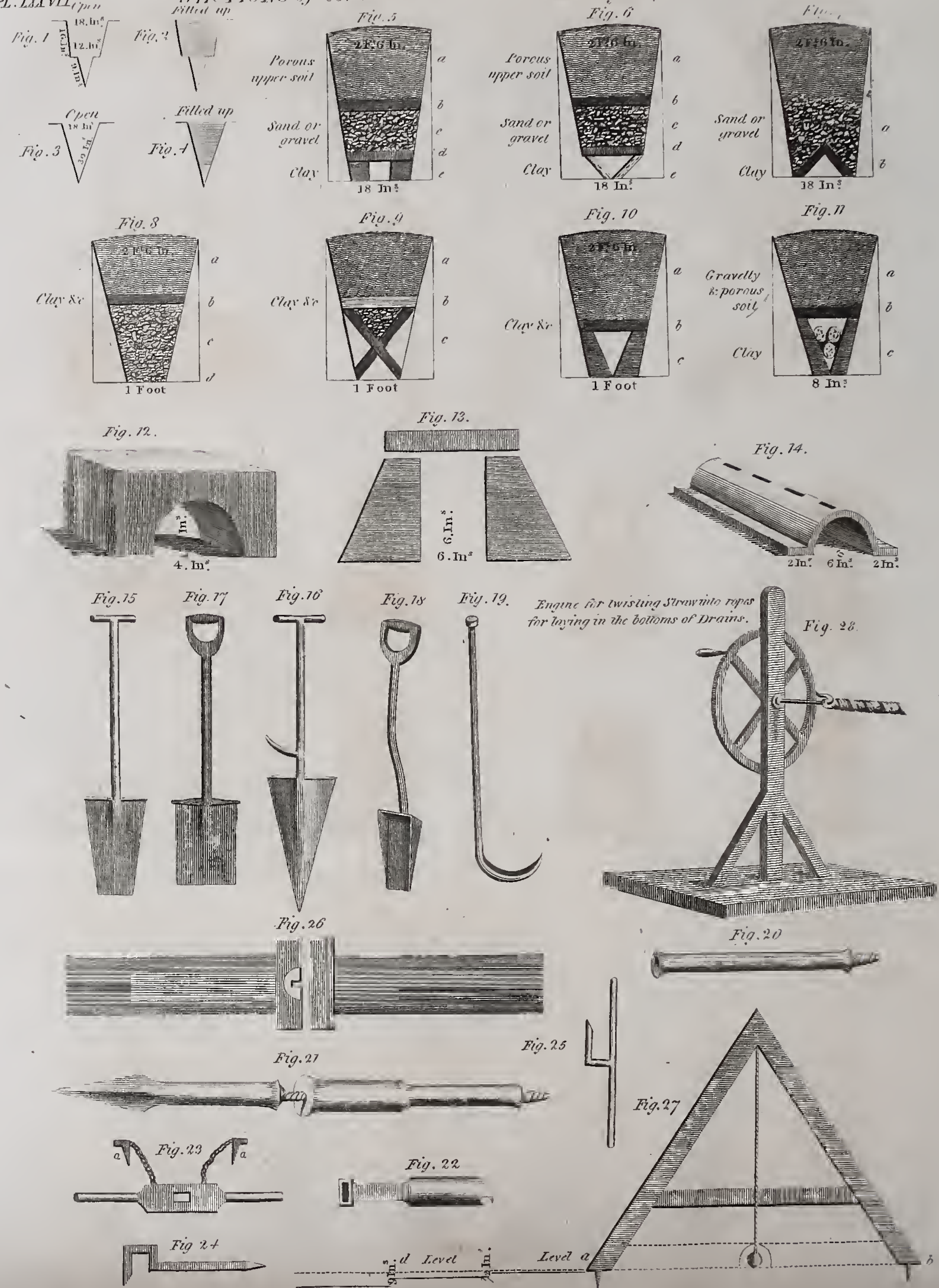
necessary, in digging of them there is a considerable art, as they should be formed with as much truth and exactness as possible, which can only be done by such persons as are conversant with the nature of the business. Such labourers as are not dexterous in using their tools seldom make them well. The most general method of performing this sort of work is by admeasurement, at so much a rod, or a score rods, which necessarily induces the workmen to do as much as they possibly can; they should therefore be frequently inspected, to see that they keep to the proper and required depth, and that the earth taken out be laid in such a manner as not to fall down again into the drains in time of filling them, and that the surface mould be kept on one side free from the clayey or other material of the inferior stratum. Those who have been in the habit of draining land, now in general begin to see the great advantages of making their drains, in these cases, when there is any declivity in the ground, in a slanting direction across it, instead of the old method of conducting them according to the nature or inclination of the slope. By attending to the former mode of cutting the drains, the wetness is not only more effectually removed, but by allowing the water to pass away in an easy current, they are rendered less liable to be choked, or, as it is frequently termed, blown up, by which artificial oozings of water are sometimes formed in such places. But where grounds are either quite or nearly level, as is the case in many of the western districts, it has long been a general practice (and where the wetness to be removed arises entirely from surface water, by no means to be disregarded), to cut the drains at the different distances of about sixteen, twenty four, and thirty two feet from each other, across the fields from different ditches, according to the circumstances of the lands; or, indeed, where the drains, either from some slight unevenness of the surface, or other causes, can only be made to flow at one end, to avoid cutting them further on one side than where the ditch is capable of taking away the wetness. In cases where the declivities of a piece of ground are various, and have different inclinations, the drainer should constantly attend to them, and direct the lines of his drains in such a manner, as that they may cross the higher sides of the different declivities in a slanting direction.

The depth of all such drains must depend upon the nature of the soils, the positions of the land, and a great variety of other more trifling circumstances. It was formerly the custom to make them three or four feet in depth, but by modern drainers they are rarely made to exceed thirty, or perhaps a few inches more, the most general depth being from twenty-four to twenty-six inches. As the main drains have more water to convey away, and are generally of greater length, than the lateral ones, they should always be cut somewhat deeper; and where the materials of the soils are porous, the greater depth they are cut, the more extensively they act in lowering the wetness of the land to such a degree as that it can be little injurious to the crops, whether of grain or grass, that may be produced upon it: when however, the operator reaches any impervious material in the soil, through which the moisture cannot pass, it will be quite useless to dig the trench to a greater depth. If it be clay, by going a few

8°

PL. LXXVII.

SECTIONS of covered DRAINS, & draining Implements.



inches into it, a more safe passage for the moisture may however be secured. It must notwithstanding be invariably attended to, that the depth be such as that the treading of heavy cattle may not displace, or in any way injure, the materials employed in constructing or filling them. It may be noticed too, where the horses in ploughing tread in the bottom of the furrow, at the depth of four or more inches below the surface, that, if eight or ten more be allowed for the materials with which they are filled, when the depth of the trenches are not more than twenty-four inches, there will only be nine or ten inches of earth for the support of the horses in the exertions of ploughing. Where the earth has been stirred, such a depth must undoubtedly be too little, and in some measure proves that drains of such a depth are not sufficient. By cutting them down to the depth of two feet and a half in the stiffer soils, they will seldom be penetrated to, or have too great a depth; and in the previous ones a still greater depth is highly useful, and constantly to be practised.

The practice of cutting the drains as narrow as possible, which has lately been much attended to in most of the eastern districts, is of much importance, as it causes a considerable saving of the matters employed in filling them up, whether they be wood or straw; but in cases where bricks or stones are employed, this cannot be so much attended to; however, there is seldom, it is observed, a necessity for a greater width than about a foot, provided the stones be *coupled* at the bottom, or thrown in in a mixed way; nor more than sixteen inches where laid in the manner of a sough or a channel. But of whatever depth the materials may be, the earth or mould by which they are covered up should not be less in depth than a foot; in arable lands it should indeed be more. The dimensions are represented in plate LXXVII. in which fig. 1. represents a *shouldered turf-drain*; the inverted turf resting more firmly on the shoulders than in the common method without them, leaving the part hollow below. Fig. 2. shows it filled up. Fig 3. represents the *wedge-form* of drain, a part of the bottom of the wedge part being removed before it is put in again. Fig. 4. shows it when filled up. And fig. 5. is the section of a hollow drain: *a* loose mould thrown in to the depth of one foot; *b* sod inverted two inches thick; *c* round land stones one foot thick; *d* flat stone or cover four inches thick; *e* sough or conduit six inches square lined with stone. Fig. 6. is another section: *a* loose mould as above; *b* thin sod inverted, straw, heath or rushes; *c* round land stones or faggots of brush-wood; *d* flat stone or cover four inches thick; *e* triangular opening six or eight inches. Fig. 7. is a section of drain: *a* land stones as before; *b* triangular or coupled opening six or eight inches. Fig. 8. is a section of hollow drain: *a* loose mould or gravel thrown in one foot; *b* sod, straw, heath, or rushes, four inches; *c* land stones thrown in; *d* one foot eight inches thick. Fig. 9. another section of a covered drain: *a* loose mould thrown in one foot; *b* straw, &c., six inches in thickness; *c* brush wood laid longitudinally and suspended by cross billets of wood, having bottom and sides to the height of cross billets, open one foot six inches. Fig. 10. is another section of a hollow drain; *a* loose mould or gravel one foot; *b* sod inverted six inches; *c* pipe or opening formed

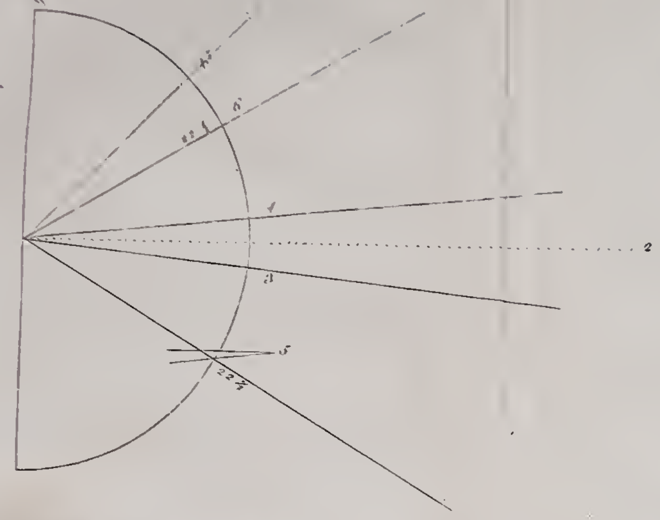
by draining-spade, one foot deep and eight wide at shoulders. And fig. 11. is a section of a covered drain ; *a* drain one foot deep; *b* clay trampled in six inches ; *c* pipe or opening formed by draining-spade one foot deep, and filled with three large ropes, laid lengthways,—are proper for such lands as are wet from surface water, or the stagnation of it in the upper soil.

It is an advantageous practice in some cases, where the land to be drained is in such a state as to admit of it, to make use of the plough in opening the upper parts of the drains. The method of performing the business, as described by a celebrated drainer, is this : " When the drains are set out in the field, which is commonly done at the distance of about a rod from each other, two furrows are drawn with a foot-plough, a *baulk* of about fifteen inches in width being left between them, which baulk is then split, by means of a strong double breast-plough constructed for the purpose, and a clean furrow fourteen or fifteen inches in depth left. In some cases, where the soil is so deep as to require it, as it is advantageous to touch the surface of the clay by a second use of the plough, the furrow is sunk to the depth of eighteen or twenty inches ; it is then in a state of preparation for the land-ditching spade, by the use of which the drain may be dug to the depth of fifteen inches more, as narrow as it is capable of being made." When ploughs for the purpose cannot be readily procured, the business may be performed by means of a common plough, and a strong team, so as to stir the ground to the depth of five or more inches, making a double furrow by throwing the earth on each side, and letting a baulk remain in the middle. This baulk is, to be raised in a similar manner, by a second bout of the plough ; and then as much depth as possible is to be got by going twice in the open furrow with an ordinary double breast-plough. The loose mould and irregularities are next shoveled out to the breadth of a foot, by which a clear open furrow is produced of different depths, according to the nature of the soil and the ploughs employed, but most about eight or nine inches. One spit is afterwards dug out, to the depth of fifteen or sixteen inches, with the draining spade, producing ultimately a depth of two feet or more. Where this depth is not sufficient, which is often the case, one or two spits more are thrown out, by which a depth of three or more feet is frequently formed.

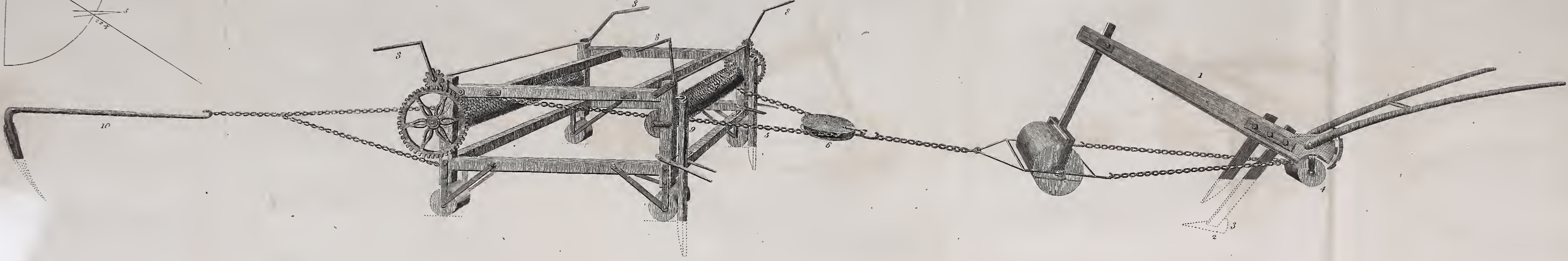
As where a large quantity of water is made to flow in one drain as from the junction of many collateral branches with it, though it be made larger and of greater depth in consequence of that circumstance, it may be liable to fail in taking away the water, the effect of which must be very extensive, from the course of so many others becoming impeded in consequence of it ; it is a good rule, therefore, not to connect a number of drains with the same outlet, or discharging one ; but to form them, especially where there is much declivity in the land, as much as possible in a distinct and separate manner.

The spades employed in forming the drains were formerly made of different sizes, so as to follow each other, narrowing in breadth in a regular manner to the bottom. Lately, however, the plough has been made to supply, in the way that has been just shown, the places of all of them except the lowermost, or the two lowermost ones where

Pl. LXXVIII 8°



Mr. Lumbert's Mole Plough.



the drains are required to be deep. Scoops are likewise useful tools in this business; as by drawing them along the bottom of the drains, all the loose and detached particles of earth may be cleared away, and they be prepared for the materials with which they are to be filled. The expenses of forming drains of these sorts must obviously be different according to circumstances and situations. Implements of this sort of various dimensions should be had, in order to suit the different sizes of the drains;—representations of which may be seen by consulting plate LXXVII. in which fig. 12. is the upper draining-spade. Fig. 13. lower draining-spade pointed at the bottom. Fig. 14. wooden spade for peaty soils. Fig. 15. bottom shovel with turned-up edges. Fig. 16. Scoop for cleaning out and smoothing out bottom of drains.

Besides these implements, a borer or auger is necessary, for the purpose of perforating through the impervious strata after the drains have been cut, or searching for coal, or subterraneous minerals. It consists of several different rods or pieces which screw together, to such lengths as may be required, as well as of a punch and chisel, with wooden handle, wedges, and two iron keys for screwing and unscrewing the rods. At. fig, 17. in plate LXXVII. is shown the rod-screw for the auger, four feet in length. Fig. 18. is the chisel and punch for cutting stones. Fig. 19. is the auger or shell or wimble. Fig. 20. is the wooden handle with iron plates on both sides to strengthen the holes for rods; *a a* wedges. Fig. 21. is the iron key. Fig. 22. the iron handle. Fig. 23. the boards used in boaring with the auger to keep it steady. Fig. 24. is an instrument for levelling drains, water-courses, &c.: *a b* the sides of the frame; *a d* a line marked off.

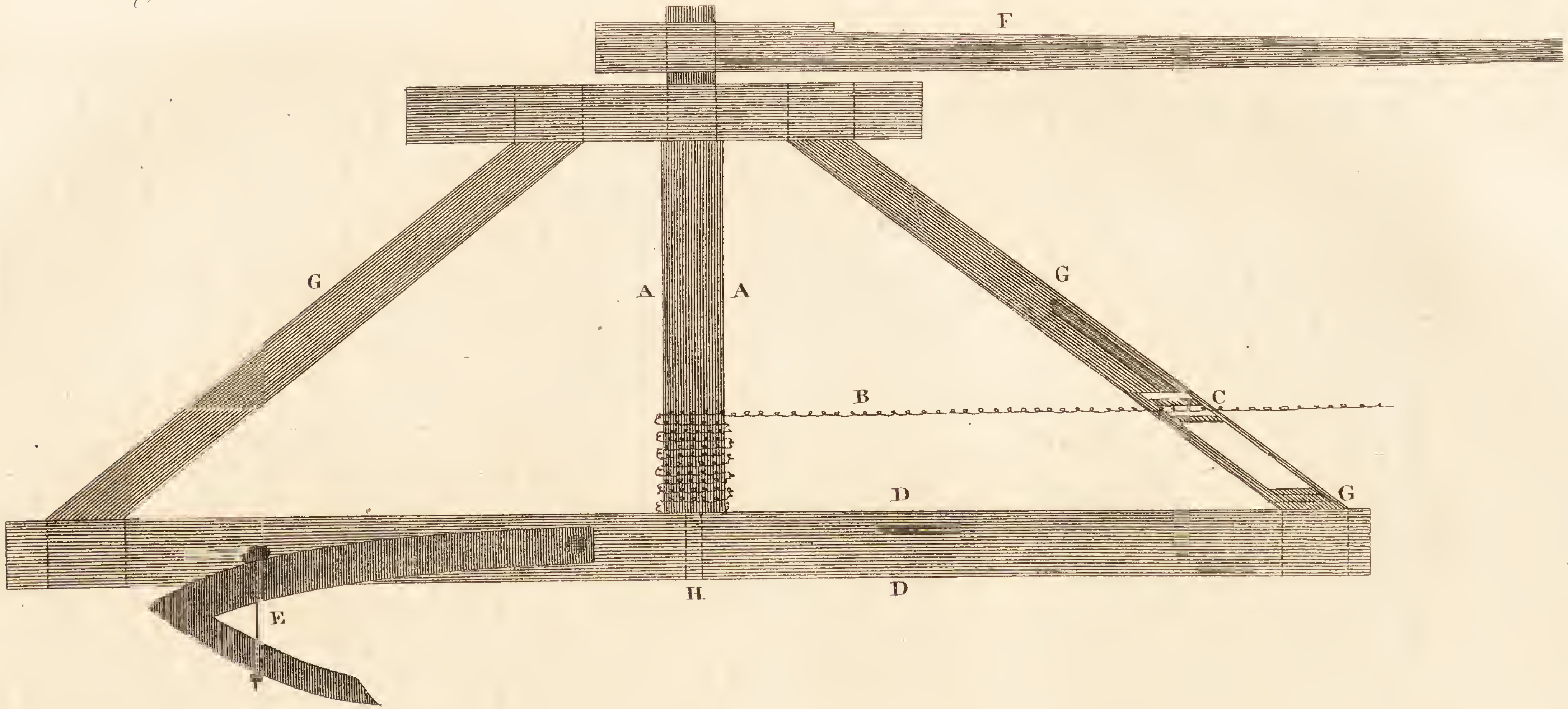
Various implements of other kinds, somewhat in the forms of ploughs, have been invented at different periods for the purpose of forming hollow drains at once in land, but hitherto probably without that perfect success which might be wished for in such instruments. That which was not long ago invented by Mr. Adam Scot, termed a mole plough, and which has since, perhaps, been in some degree improved by Mr. Watt, of Bingley, may answer in some particular kinds of soil, at certain seasons of the year; but from the great strength which is required to draw it, it is obvious that it can only be employed under peculiar circumstances of soil, season and strength of team. It has long been a desirable object to have an effective implement of this kind, that may be generally made use of, and which performs its work at a cheap and easy rate. And such an instrument seems to have been lately presented to the attention of the farmer by Mr. Lumbert. A representation of the plough, and the windlasses by which it is drawn is given in plate LXXXVIII. in which fig. 1 is the beam. 2. the mole, to which segments for lengthening it screw on at 3. 4. the roller at the heel on which it presses. 5. the chain, from 50 to 60 yards in length, which winds on to the two cylinders, 7, 7. 6. a pully, round which the chain 5. plays. 8, 8, 8, 8. windlasses, turned each by two women. 9. stays which, entering the ground, assist in keeping the machine steady. 10. the anchor. The proportion and respective angles of the different parts of the implement may be found by the scale. It is wrought by eight women; and Mr. Lumbert contracts for the work at $1\frac{1}{2}d.$ the perch, lug, or rod of $5\frac{1}{2}$

yards, his foreman agreeing with him for doing it at three farthings, the machine being found, who pays himself and the women out of it. It performs from 150 to 200 perches a day; and 300 have been done. 200, at three farthings the perch, amounts to 12*s.* 6*d.* a-day; the eight women, at 8*d.* each, amounts to 5*s.* 4*d.*, leaving 7*s.* 2*d.* for the foreman's pay, and the repairing of the chain, which breaks often, and wants a false link whenever that happens. It was found to move, on an average, 5 yards in a minute; but much time is taken up by moving the windlass, frame, and anchor. The inventor goes to any part of the kingdom with the machine, at 1½*d.* the rod; but when to a distance, must have insured work in the proportion of 200 rods for every mile out. He sells the tool for 50 guineas, as he has a patent. It usually goes 17 or 18 inches deep, but can go deeper; and has been found very effective on clayey soils, the drains continuing to run after many years. It has since received an additional improvement by Mr. Rogers in the application of a long lever, to the end of which a horse is attached, so as to form the business with facility as shown in Plate LXXIX. By this means one horse gains the power of thirty. F is the long shaft or lever, fixed on the square top of the upright axle AA in centre of the frame, being moved round by the horse. B a strong chain attached to the axle, which winds up as the horse passes round, bringing the plough forward, and not rising more than fifteen inches in winding up forty yards, which enables the horse to step over it every round. It is still further kept down by passing between two friction pulleys CC to the plough. E is the anchor which renders it steady, and is made of wood or iron. H an iron pin passing through centre of cross bar in frame D next the ground. GG side pieces formed into upper and lower horizontal timbers, to render the whole strong. The expense without the chain is only about two guineas.

The best or most proper season for performing the business of hollow-draining, does not seem to be yet fully determined by those who have been most engaged in the practice; some contending that winter is the most advantageous time for the purpose, while others think that summer should always be preferred. It would, however, appear, from the consideration of the different circumstances of the lands at these periods, that neither of them are the most favourable seasons for this kind of work; but that the more early spring months, when labourers can be procured, and it does not interfere with the other operations of the farmer, are by much the best; as, in these, the difficulties arising from the hardness of the soil, and the scarcity of labourers, in the summer season, and the kneading and plastering, as well as the cutting of the land by the cartage of materials in the winter, are equally avoided. Besides, in these months the land is not only in the most suitable condition for the workmen, but the danger of the new drains being destroyed in some situations by the floods caused by the autumnal rains, is guarded against.

Where, however, the farmer has a great deal of work of this kind to perform, it will be impossible to do it all in these early months;

Rogers's improved apparatus to the draining Machine.



he must proceed with the business at other seasons when frost is not present. It is the most common practice of farmers to drain stubbles in the winter, and fallows in the summer months. Some expert drainers, however, think this sort of work much better performed when the land to be rendered dry is under a layer, or sown down with seeds of the grass kind. And it has been remarked that the plough employed for first opening the furrows performs better on land in this state. As the limits between the wet and dry parts of land can be the most readily distinguished when it is in summer fallow, and the little inequalities of surface be most easily levelled down, that period is by most farmers considered as unquestionably the most proper time for forming such drains as are merely to convey away the surface wetness.

Different sorts of materials may be employed for the purpose of filling drains, to which the drainer will be directed by the ease and facility with which they may be capable of being procured. Those in most general use, are stones, wood, straw, heath, and bricks constructed for the purpose. Where quarried stones are employed, and the drain constructed at bottom in the manner of a conduit, the trench should be made sufficiently wide to admit two side stones, about six inches apart, and of equal height, a flat stone being placed over by way of cap; and thus a secure drain formed. Another mode of constructing stone drains, and which has been found considerably cheaper and more secure, is that of using three stones of a thin, flat form, placing one against each side of the drain, so as to join at the bottom, and capping or covering them with the third; thus forming a sort of triangular passage for the water. When made in this way, it is said that they are neither subject to be filled up, nor to obstruct the current of water that may pass along them. They do not, like those formed in the usual way, cause obstruction by sinking unequally into the ground; but by subsiding in a regular manner altogether, keep the course for the water free. Besides, in this mode a less quantity of stones is generally required; which is a circumstance of great importance in many situations. The first method is, however, only applicable in cases of springs: but this as well as the mode just mentioned, is obviously much more expensive than that of throwing in small stones in a loose manner.

In particular districts, as Essex, and some other eastern counties, where drains are filled with stones, they employ the small flints from the chalk or stones from gravel-pits, or such as are picked from the land. But it is only in drains of very little extent, and where little water passes, that such very small stones can be used with safety and advantage; and as stones, of whatever size they may be, require a greater width in the bottom part of the drain than where wood or straw is made use of, the expense of forming them will be considerably more. In every case the stones used should be perfectly clean and free from clay, or any other earthy matter that may adhere to them, and be placed in the drains in such a manner as that none of the mould or earth may get in along with

them, which might be detrimental by filling up the holes and crevices between them.

It has been asserted by some, that drains filled with wood, and covered in the common way with straw or rushes, are superior to stones or any other kind of materials; for as the wood decays the water continues to pass. But that when filled with stones, and the drains stop up, which in time must often be the case, the earthy matter becomes quite solid round the stones from their not decaying, and the passage of the water for ever prevented; which is not the case where bushes or wood are employed, an oozing or draining being constantly perceptible. Besides, by a repetition of the business, and making the drains in a transverse direction to the old ones, the advantage of filtration through the rotten wood is preserved, and the spewing up of old broken and injured drains removed and carried away. It has been further observed, that as bushes form more numerous cavities than either stones or poles, they are less liable to be stopped up, while the percoration or passage of the water is promoted more than by substances of a larger and more solid kind. Black-thorns are preferred by some, from much experience, to all other sorts of materials for the purpose of filling drains, probably from their not decaying so quickly as many other sorts of wood, and their affording an easy and free passage to the water by their bushy nature.

By some it is a practice to employ wood in filling drains, by depositing the faggots or brush-wood which is made use of, upon small bunches of wood in the form of billets set upright in the bottom of the drain. But though this method is said to have succeeded in some of the more northern parts of the island, and is perhaps capable of being practised with advantage in such lands as are not under the state of arable cultivation, it has been found that in some cases the feet of the animals employed in ploughing have sunk in such a manner as to remove the materials that supported the brush-wood, and by that means obstructed the passage of the water. Where this mode is followed, especially in lands that are to bear the treading of cattle, care should be taken to have a considerable thickness or depth of earth upon the drains. It is remarked by the reporter of the state of agriculture in the county of Caermarthen in Wales, that the most complete method he is acquainted with, is that of cutting the strongest parts of willows, and other aquatic plants, into lengths of about twenty inches, and placing them alternately in the drain, one with the end against one side of the bottom, and the other with it against the opposite side, so as to form a sort of cross-work. The stronger parts of the wood being laid in this way in the drain, the space between on the upper side is filled with the small twigs or brush-wood that has been left, and the whole is finished by a light covering of straw, rushes, or such like substances being laid over them. It has been observed, that the boughs of willow, alder, asp, and beech, are extremely durable when put in such drains in their green state before the sap is dried up; but that when suffered to become dry before they are put under the ground,

they decay more quickly. The reporter has seen willow taken out of a bog where it had laid thirty years, with the bark fresh and sappy as if just cut from the hedge; and it is well known, he remarks, that beech laid in the water green will continue sound for almost any length of time. It has likewise been remarked by Mr. Majendie, that wood of eighteen years growth is much more durable than such as is only ten or twelve.

On filling drains with straw, where the soil is a close retentive clay, it is advised that the drains should be made near to each other, shallow, and filled with that material only, as it is quite unnecessary to employ wood or other more durable materials, where the sides of the drains are not likely from the nature of the land to crumble down into them. In such cases, the distance of the drains should seldom be greater than three or four yards from each other, and about twenty inches in depth; or such as may be easily produced by first using the plough, then shovelling up the bottom of the lowest furrow, and afterwards taking out one spit with the land ditching spade: drains formed in this way, with the materials, cost about two shillings and sixpence a score rods. It is found that drains cut through tough retentive clays, and managed in this way, will be found soon after they have been made to have formed over the straw employed in filling them, an arch of such strength as to support the weight of the soil, and any thing that may come upon it in the course of managing the land; and that in the course of twelve or eighteen months, from the straw being an uniform substance, it is wholly rotted and carried away, leaving clear open pipes in such drains as the water may have had a free and easy passage into, by a proper attention having been paid to the filling of them with the most open and porous parts of the surface of the land. But the best method of filling hollow drains with straw is probably that which has been lately practised, of twisting it into ropes. The mode which has been most generally followed, is that of treading into the drains loose straw; but it may be forced much more effectually to the bottom of the drains, and convey the water away much more readily, and be also of much longer duration, by being wound into a firm hard rope, about the size of a small cable, while the business of filling the drains is rendered more expeditious, and the quantity of straw which is necessary not by any means increased. This method has been practised by Mr. Bedwell, in the county of Essex, with great success and advantage; and he has found that the straw is tougher and in a better condition for winding after it has been picked over by cattle than in its fresh and dry state. A representation of a machine for this purpose may be seen in plate LXXVII. at fig. 25.

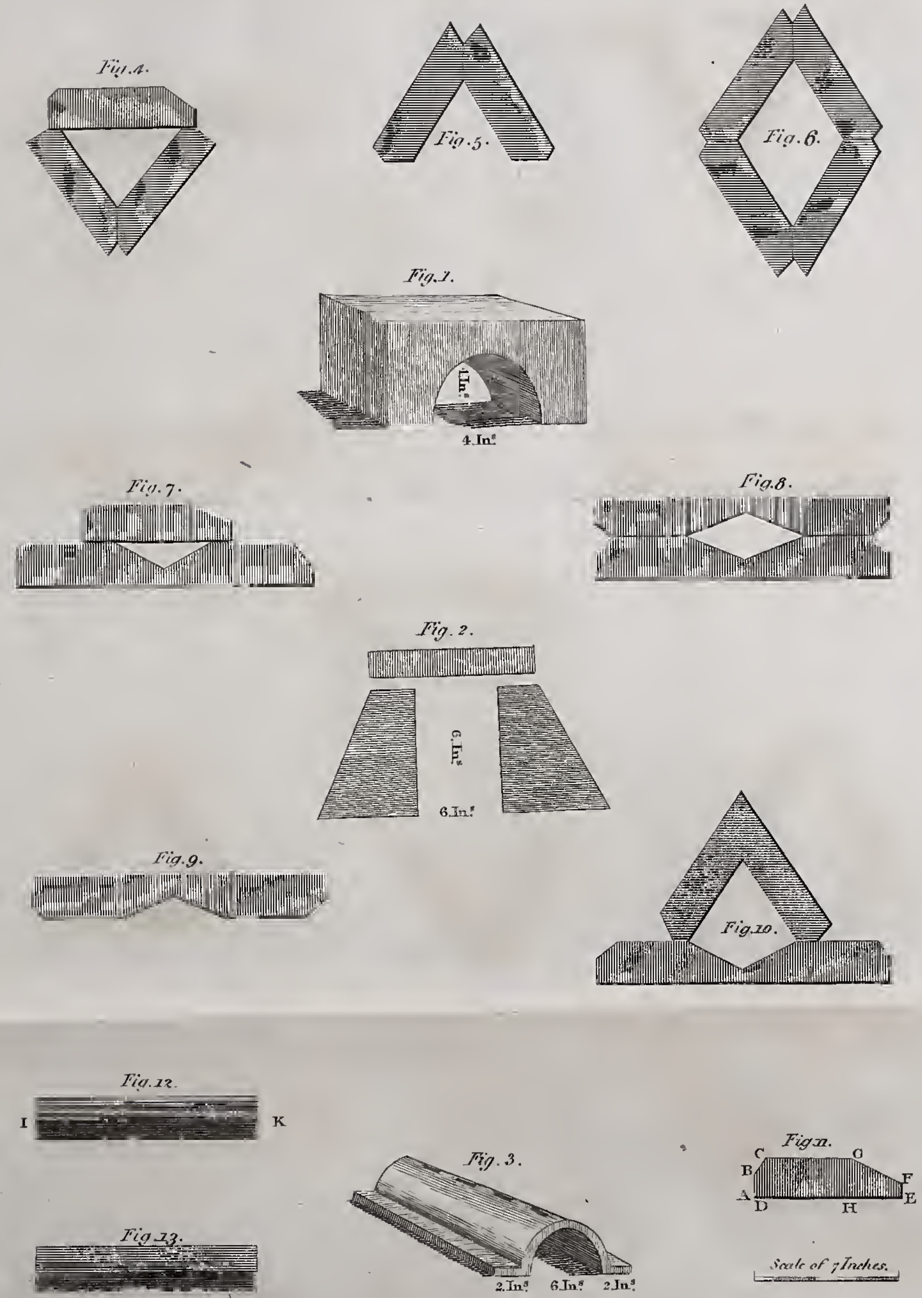
Bricks are sometimes made and employed for the purpose of draining, but they are in general too expensive, and not well suited to surface draining, though they are proper for such drains as are to carry off the water issuing from springs; in which cases a large tract of land may frequently be laid dry, without employing any very great quantity of such materials. The bricks used in this way have mostly an excavation for the water to pass along, and are

placed in stiff soils upon the bottom of the drains; but in such as are soft, they are mostly laid one upon the other so as to form a sort of cylindrical passage for the water; or they may be placed on a foundation made of common bricks: representations of bricks for this use may be seen in plate LXXX. in which fig. 11 represents a *draining-brick* chiefly used for small drains, such as for conveying water to houses. Fig. 2. shows another sort of *draining-brick* for constructing a large square drain laid without common brick; and fig. 3. exhibits another form of *draining-brick* for forming larger sorts of drains. Other sorts of bricks for this purpose have been invented by Mr. Ashworth of Turton near Bolton, in Lancashire, which may be seen in the same plate; in which fig. 4. represents the form and manner of placing them in the draining of land, in which 84 bricks are required to every eight yards, while with common bricks 192 are necessary; of course there is a saving of 108 in this way in every eight yards of draining. Fig. 5. is another form of brick, in which 55 bricks are sufficient for draining eight yards in length; by which 137 bricks are saved in that distance. Fig. 6. is a form which takes 110 bricks to complete a drain of the same length; by which 82 bricks are saved. This form is only necessary where much water is to be conveyed away. Fig. 7. is another form which employs and saves bricks in the same proportions as fig. 1. Fig. 8. is a different form of brick, that employs and saves in the proportions of fig. 3. It is particularly useful in draining boggy soft lands, and where there are quicksands. Fig. 9. is another form that saves bricks as in fig. 2. Fig. 10. is a different form that takes the same as in figs. 3. and 5. Fig. 11. is a cross section of one of the bricks 7 inches broad and two in thickness. The perpendicular line from A to B is 1 inch; the slope from B to C $1\frac{1}{4}$ inch; the distance from A to D by a perpendicular line from C is full $\frac{1}{2}$ inch. The perpendicular line from E to F is $\frac{3}{4}$ of an inch; the slope from F to G full $2\frac{1}{4}$ inches; the distance from E to H by perpendicular line form G is 2 inches. Fig. 12. is a full-length view of the brick, exhibiting the narrowest slope. It is 10 inches from I to K. And fig. 13. is another whole-length view of the same brick the contrary way, presenting the broadest slope.

Pipes made of burnt clay, about eighteen inches in length, having an opening three or four inches in diameter, are also made use of in this way in the county of Essex, and some other districts; but from the narrowness of their apertures they can only convey a small quantity of water, they are therefore more suited to the conveyance of water from springs or other places for domestic uses, than for the purposes of draining land.

As it is a matter of considerable importance in the business of draining to have the work properly executed, on this account the persons who perform the cutting of the drains should not be contracted with for the filling of them, but merely for the cutting and leaving them clean in the bottoms. The filling being performed by labourers hired by the day, in order to guard more effectually against negligence, and the want of proper attention to the work; and even when done in this way, either the farmer himself, or

Draining Bricks.



some other person who can be trusted, should frequently inspect the performance. By consulting the annexed plate, the methods of filling drains in different cases may be better understood.

Besides the modes of draining which have been described above, those by which water is removed from *mines*, *quarries*, and *pits*, as well as the wetnesses on the tops of hills and banks, contiguous to low grounds, but applied from high lands at some distance by means of metallic substrata, are fully explained in Mr. Elkington's work on draining of land.

Wells.—On the principles that have been already mentioned respecting the nature and direction of the different stratified materials that constitute the earth to a considerable depth below its surface, may also be explained the reason, in digging wells, that if strata of sand, gravel, or other loose porous materials, be first met with, water can seldom or ever be found until clay, or some other impervious substance, be reached; or, where clay, or other impervious material is begun with, until the operator has dug down or proceeded to a bed of some porous substance, such as rock, sand, or gravel. They also show, that by digging wells in particular situations, in valleys or level grounds, where the water descends between the strata from a distance at a great height, by building up, or otherwise raising, the top of the well, so as that it may not give way by the pressure of it, it may be raised to a considerable height above the ordinary level of the well; and thus, in many cases, be rendered more useful than it could otherwise be. Curious instances of this nature have been frequently noticed by writers. And further, that by widening the bottoms of wells in some cases, as where the water filtrates between the strata in too sparing a quantity, it may be augmented nearly in a similar proportion to the extent of the opening. Practical examples of these kinds may likewise be met with in the Philosophical Transactions.

As from the stagnation and retention of too much water, in or upon lands, whether in the state of tillage or that of grass, much injury must be produced;—in the first case, by its rendering the soil too moist and poachy for being ploughed up sufficiently early for many sorts of grain crops, and for the manure being properly incorporated and preserved in it; and in the latter, by the cold which it causes in the winter season, rotting, weakening, and thereby rendering the absorbent roots of the grasses incapable of performing their offices; it is obvious, that the operation of draining must constantly be effectually performed, before any other sort of improvement can be attempted with the least prospect of success: until this has been fully accomplished, it is indeed impossible to know whether the land be suitable for the growth of crops, or what benefits may be produced in it by the application of manures. And, as the removal of such degrees of wetness as prove detrimental to lands, constitutes in most places, and especially in those of the fenny and boggy kinds, an improvement that must be of great utility and duration, it would seem proper that the proprietors should, in most cases, be at the principal expense of the business, as it is seldom performed in an effectual manner when undertaken

by tenants, unless they are unusually spirited, or have such length of leases as affords them the certainty of obtaining the full reward of their exertions. When this sort of improvement is made in the early period of a lease, it would, however, be proper in the proprietors to demand a suitable interest on the sum advanced, and, upon a renewal, to have it added perhaps in the way of rent.

From the whole of the facts and circumstances that have been mentioned, concerning the nature of the different strata that constitute the earth, the directions in which they are deposited in it, and the manner in which water is carried down, confined, and forced to the surface of soils, so as to become, in different ways and degrees, injurious, it would seem evident, that springs of such kinds as can be in any material degree detrimental to land, need never be apprehended where there is a great depth of porous material, such as sand or gravel, without the intervention of clayey or other impervious strata; or in the contrary situation, as where the clayey, marley, or other impervious body, extends to a considerable depth. This is a matter that should, therefore, be constantly kept in the minds of those engaged in the business of draining lands; and, that where the mischief proceeds from superficial wetness, caused by the stiff, retentive nature of the soils, there must be particular attention paid to the nature and position of the land, the direction, cutting, and mode of filling the superficial hollow drains employed in such cases; and, at the same time, to the ridging and furrow-draining, as well as the loosening of the soil to a good depth, when in a state of arable cultivation; as upon a due execution and combination of these, the success of the drainer must greatly depend.

SECTION IX.

Paring and Burning.

THE practice of bringing land into a suitable condition for the growth of grain or other crops by means of fire, or the operation of paring and burning the surface or sward, is probably a method of cultivation that was adopted at a very early period. It is a process by which various changes are produced in the materials of the soils on which it is employed; some of which would seem to lessen rather than improve their fertility, while others have obviously the power of promoting and augmenting it in a very considerable degree.

The action of the fire during the time of the combustion, especially when carried to a great height, by forcing off and dispelling much of the moisture and elastic principles that they contain, as well as by reducing the proportions of vegetable and animal matters which may be mixed and incorporated with them, must have the effect of producing some degree of deterioration; while

by its conversion of the fresh vegetable products, as the different kinds of coarse plants and grasses, into ashes of an alkaline, saline nature—which, as has been already seen, possess the property of quickly rendering the portions of vegetable materials which may remain proper for supplying the nutrition of plants—and by combining oxygen with the argillaceous, earthy, or other particles contained in them, in such a manner as to be easily parted with during the incipient stages of vegetation, great advantage and improvement must unquestionably in many cases be produced. It would seem to be chiefly on the former principle that the crops are generally found to be so abundant after land has undergone this process; as, the saline substance contained in the ashes, though frequently small in quantity, by bringing such parts of the soils as were not before in a fit state for the purpose of being applied to the support of vegetables, suddenly into that situation in which they may be taken up by the absorbent roots of the plants, a vast immediate fertility may be given, but which must soon have the effect of exhausting the ground, if grass or some other kind of green crops be not cultivated in due rotation upon it. That some effect of this sort takes place, in such cases, is shown by the general experience of the most correct practical agricultors.

There is also another way in which the saline matter thus formed may be conducive to the purposes of vegetation; which is, by the great stimulus which it is known to afford to the roots of growing plants, by which they may be induced to take up a larger proportion of nutrient matters from the soils on which they grow. And on lands prepared in this manner, especially where they are of the clayey kinds, it is probable that in some instances so much oxygen may be combined, by means of the fire, with the particles of the clay, as, in particular situations and circumstances, to render it capable of forming nitrous acid; as in the case with imperfectly-baked bricks, which, where lime is made use of at the same time with the ashes, may constitute a sort of calcareous nitre; a substance which experiment has shown to be highly favourable to the process of vegetation.

It has been lately suggested by Doctor George Pearson, upon the analysis of a peaty substance, from near Tingrith in Bedfordshire, the ashes of which were found by Mr. John W. Willaume to be highly beneficial as a manure, that instead of accounting for the effects of this process by the supposition of alkaline or other salts, of which, he thinks, there is little evidence, as on trial he has not detected them in any efficient quantity, they must be ascribed to the *oxide* of iron which such earth and ashes contain*.

In the method of cultivating lands by means of paring and burning the surface, such losses or deteriorations of soil as may be sustained must evidently, as has been just stated, be produced by the

* It has been generally supposed by agriculturists that the *sulphate of iron*, or what is commonly termed *vitriol* of iron, was poisonous to vegetables; but this seems only to be the case when in too large proportions, since under other circumstances its effects appear to be considerable in promoting vegetation, as may be seen by consulting Dr. Pearson's ingenious paper in the fourth volume of Communications to the Board of Agriculture.

quantity of vegetable or animal materials which may have been consumed or dispersed in the state of carbonic acid or other aërial forms; as it is sufficiently known that not a particle of the real earthy matter of the land can be destroyed or carried away by the process; it being left in most cases, where the business has been properly performed, probably in a much more mellow and friable condition than it was before the commencement of the operation, and perhaps more suited to the absorption of elastic principles from the surrounding atmosphere. And experience has shown, that whatever may be the proportion of saline matter which is formed in this way, a great deal depends upon the ashes which are produced; as it has been found by those who have been largely engaged in the practice of this husbandry, that on those parts where the ashes were spread out upon the land as soon as the process was finished, the crops were highly luxuriant and productive; while on those where they had been from necessity taken away, they were very mean and inferior, not being worth more than from an eighth to a tenth of the value of the others. The saline substances that are formed during the process of paring and burning, have been found to be the fixed vegetable alkali and vitriolated tartar; in the latter case the alkali of the consumed vegetable matters uniting with the sulphuric or vitriolic acid, which is frequently found to exist in some state of combination or other in soils. These substances have been found by experiment to be capable of promoting the growth of vegetables in a considerable degree.

But in addition to these modes, in which the practice of paring and burning may be beneficially employed in the cultivation of land, there are some others which seem of a more mechanical nature; such as its reducing the various kinds of coarse vegetable productions, as heath, furze, different sorts of dwarf shrubby plants, tough benty grasses, rushes, and many other aquatics, into such a powdery carbonaceous state, as that, by the ready action of other substances upon them when thus reduced in the soils, they may become useful in promoting the growth of proper kinds of vegetables; but which, without undergoing this process, could not by any means, from their great elasticity and almost indestructible properties, be prevented, for a very considerable length of time at least, from rendering the ground too light and porous for growing any sort of grain crops.

The state or condition of the soils, in so far as respects their textures, as has been already suggested, must likewise in many cases be greatly improved, being by such means, when properly performed, rendered much more mellow and powdery, and thereby more proper for the admission of the fibrous roots of the growing plants, as well as more capable of minutely dividing the particles of the manures, of whatever kind they may be, that are afterwards applied to them, and consequently of affording a more full and equable supply of nourishment to the crops that may be cultivated. And further, from the process radically destroying, in most instances, when well performed, all sorts of plants of the weed kind that may have established themselves in the soils which are subjected to the operation, the lands are left perfectly clean, and herefore in the most proper situation for affording the whole of the

nutritious properties which they contain to the support of the crops that may be put upon them.

From this view of the manner in which the process of paring and burning may contribute to the improvement of land, the nature of the products that are formed by it, and the effects which they produce on the soils, it would however appear to be a mode of cultivation more adapted to some sorts of land than others; as where they are light or thin, and there is much vegetable matter accumulated within the soil, (whether from the decay of successive crops of different sorts of plants for a great length of time, or the repeated applications of manures, without their having much sward or coarse vegetable products, such as have been mentioned, growing upon the surface), it may do harm, especially when a great degree of heat is not carefully guarded against, and judicious modes of cropping introduced, by lessening the quantity of useful vegetable matter which they contain, without supplying any thing as a compensation. But where they are more stiff and heavy, and there is a thick matted sward (disposed to the production of moss, or covered with any sort of rough, sour plants, whether of the grass or other kinds), it must when cautiously practised, be a highly beneficial, and, perhaps, in many cases, an indispensable mode of cultivation; not only by rendering them more open and porous in their textures, and reducing the coarse vegetable mass into that sort of form in which it can be readily turned down and incorporated with the earthy materials, but also by supplying a portion of saline matter that may operate still further in promoting their fertility.

In some cases mossy soils may, likewise, be subjected to the process of paring and burning with much benefit to the cultivator, provided that it be performed with proper care and attention. And it is unquestionably practised in various districts, without any injury being produced by the destruction of the materials that constitute such soils. On such kinds of soil more care will, however, probably be requisite to prevent the fires from becoming too violent, than in such as are composed of more earthy or less combustible substances.

But where the soils are of the sour, heavy, stiff, and fenny kinds, and where they are overgrown with such coarse vegetable productions as have been already mentioned, there cannot be the least doubt entertained of the propriety of adopting such a method of practice in breaking them up and bringing them into a state of cultivation. Indeed, however much the writers on agriculture may have differed in opinion on the propriety of paring and burning in other cases, in these they seem to be nearly agreed, and in general consider it as the most advantageous and ready method that can be employed. On inclosing the waste lands in the parish of Bowes, in Yorkshire, large portions, it is said, were subjected to the process of paring and burning, but the few persons who ploughed up the ground without previously employing this method, had great reason to regret it. It is also remarked, in speaking of bringing into cultivation the chase-lands in the county of Middlesex, that the impropriety of breaking up this kind of land without paring and burning

is manifested in the neighbourhood of Beech-hill, where land, after twenty years' inclosure and cultivation, is in a worse state now than it was originally. "Well would it be for the owners of such allotments, if they could now pare and burn it; but it has been ploughed, and, not producing more than what the vermin destroyed, laid down in so rough a state to grass, as to be incapable of being pared and burnt; the original wiry bent and dwarf shrubs are now growing in full vigour:" and that on the inclosure of Stanwell, in the same county, the allotments on Hounslow-heath succeeded well under the perfect practice of paring and burning; and ill, where the turf was ploughed without the application of fire. In the former case the land was immediately fit for turnips, tares, barley, and clover; in the latter, the tough, wiry bent, heath, and dwarf furze kept the land too light and spongy for any crop. Even rolling cannot keep it down; for its elasticity raises the soil soon after the roller has passed over it, and is of so imperishable a nature, that it is likely to plague the farmer for many years. The difference between the two methods of breaking up rough ground, is considered more than the value of the freehold in favour of paring and burning, which immediately opens a source of great profit; whereas the other proceeding leads to nothing but expense and disappointment. And in addition, it is observed, that paring and burning has more merit than any other manure, in its property of converting heath, furze, shrubs, and wiry bent, into coal, most fitly prepared for the food of plants; and that it will pulverize such a soil as much in two years as all other means can effect in twenty.

And others contend, that on any sort of soil which has not before been reclaimed from a state of waste, and where furze, broom, brambles, fern, rushes, &c. abound, these operations, when properly performed, are productive of the most beneficial consequences: that there is perhaps no other method that could be devised, so well adapted for preparing land in a state of nature, and incumbered with such productions, for valuable crops with expedition and certainty; and that on this account, paring and burning might well be considered by Virgil, and other antient writers, as a sure means of improvement. And further, that in such cases they are so at this period, may, it is thought, be proved by the concurring testimony of those to whose lot it falls to cultivate the common or waste lands in many of the new inclosed districts of the kingdom. It is further stated, that instances are frequently met with of great advantage resulting from this mode of management; and that wherever land is rendered unfit for cultivation by the incumbrances that have been mentioned, the Devonshire mattock and the paring-spade may be used with the greatest propriety.

It has been likewise remarked by Mr. Young, in the Agricultural Survey of Suffolk, that "in that district they could not cultivate without this capital assistant. It is scarcely possible, profitably, to bring boggy, moory, and peat soils, from a state of nature into cultivation, without the assistance of fire, which is the most effective destruction of the spontaneous growth, and never fails, but because the men employed do not pare deep enough."

Form cases where much destruction has been produced by the improper management of the burning in a particular sort of land, the notion of the soil itself being lessened, which has formed a great objection to the practice, seems to have originated; but it has been already shown, that no loss can possibly take place, but from the consumption of a small portion of the vegetable material that may be contained in it, either in a living or decayed state, or the dissipation of moisture and elastic matters; and that there is reason to suppose the loss in these respects is not so great as has been commonly imagined.

It has been remarked that clay soils are much more apt to be injured by paring and burning than any others. Where the flame in the heaps is allowed to burst out with great violence, the soil is apt to be reduced to a bricky sort of substance, incapable either of imbibing any quantity of moisture, or of again becoming useful in promoting the growth of plants; hence, in so far as mismanagement takes place in this respect, in so far is the depth of soil permanently lessened. But were paring and burning to lessen the soil to the degree which some people assert, there would not have been an inch of soil in the counties in the south-west part of the island many years ago. Such an objection to the practice of paring and burning, does not therefore appear to carry much weight along with it. It is no doubt very specious and plausible in theory, but the practice of ages has proved it in a great degree ill founded. By others it is, however, contended, that the large portion of powdery brick earth produced in this way has a tendency, by being incorporated with the stiff retentive mould, to render it more mellow and pulverizable; an effect which we have already suggested as useful in promoting the growth of crops.

In respect to the circumstance of the earth being reduced into a bricky substance, Mr. Young has well remarked that every one who has "ever burnt clay for manure knows, that though there are many lumps of the substance which they allude to, yet, that the mass of the heaps consists of ashes, properly so called; but when the tenacity of this soil, which is one of its greatest evils, is considered, it will be found, that bricks are an excellent addition to the soil, to loosen and open its stubborn adhesion. He has seen and examined carefully heaps of clay-ashes, amounting to many hundreds of loads, that have been burnt and applied to great profit on this soil. By paring and burning, you have therefore on it the common manure found in vegetable ashes, and in addition a substance which acts mechanically. And Hitt, he says, who wrote from practice, and whose writings abound with many just observations, remarks: "that he recommends burning of the surface as the cheapest manure, and most effectual of any; for it not only adds salts to the soil, which the burning of grass roots produces, but it opens part of the stratum of clay next the soil so much, that the roots of vegetables can afterwards feed therein; for when the turf of a piece of land has been burnt in heaps, at four or five yards apart, though all the ashes be taken away, with some of the earth, and spread over the other parts of the land, yet neither corn nor

turnips will grow so vigorously there, as on those places that were only opened by heat."

The same author adds that on loams of the better kinds, the practice has been most condemned; but here we have some experiments to recur to, which, in his estimation, set the matter in a clear light. "Mr. Wilkes, of Measham, in Derbyshire, has," he says," "for many years been in the practice of ploughing old rough pastures (the soil a stiffish loam) eight or nine inches deep, and burning the whole furrow in heaps of thirty or forty bushels each, the fires lighted by a few coals, and coal *slack*; the effect has been very great, and the improvement immense and durable. Mr. Wilkes is of opinion, from the experience of many years, that even this burning, which is twenty times the depth of common paring, does not waste the soil in the least; it does no more than break the texture of stiff soils, expelling a great quantity of water; that by exposition to the atmosphere the land re-absorbs its water, and, by the great immediate fertility, fills itself presently with more vegetable particles than it had before. Thirty years ago, his father burnt, at Overseal, exactly in the manner described, a field of ten acres, which was not then, and has not since been treated with any more favour than the fields adjoining, yet it has ever since retained a superiority.

And Mr. Young himself hollow-drained an old grass-field of four acres and a half, of cold, wet, poor loam, on a clay marle bottom; the rent 9*s*. an acre, and not worth more in its then state, perhaps, than 7*s*. In 1791 he ploughed four acres of it four inches deep, which was the whole depth of the *soil*, or surface, of different colour from the stratum beneath, between that surface and the clay marle, and burnt the whole furrow of the part so ploughed. Having no coal slack, and wood being dear, he made but four heaps in the field; the consequence was, the heat and degree of calcination were far beyond what is ever practised in common, and many persons who knew and approved of paring and burning in the common way, pronounced the field completely ruined. The ashes were spread, and ploughed in with a shallow furrow, and turnip-seed sown, and very slightly bush-harrowed. The crop was very fine, worth, to sell for feeding on the land, at least 50*s*. an acre. The crop on the burnt part double to that of the half acre. After feeding them with sheep, the land was ploughed thrice, and sown with oats and grasses. The oats produced above 7 quarters an acre, and the grass has ever since been much better worth 20*s*. an acre, than it was worth 5*s*. before. The oats on the half-acre were not threshed separately, but judged by those who viewed them, to be much inferior to the rest. About half the field has been since dressed with earth and road sullage, and once dunged slightly. It is remarkable, that in three years crested dog's tail, an excellent grass, common in the country, the seed heavy, and which, therefore, could not be carried by the wind, began to appear, and has been increasing ever since. There is at present no perceptible difference between the part burnt, and the other not burnt; if any thing, the burnt is best. These two experiments prove, he says, if any thing can, that paring and burn-

ing does not lessen the soil, in its most excessive application, and that it works a very great improvement on loams.

On sandy soil, Hitt, a practiser of this husbandry, has, he says, observed that it improves them as much as any other; and he has seen some fields thus worked in Suffolk and in Cambridgeshire, and improved by it, though under a course of crops, by no means admissible. There is not the least reason, from analogy, to doubt the effect of it on this sort of land.

And on chalky soils, he contends, there is "a much more ample field of experience, as it has been, and is the common method of breaking up downs in every part of England. On the Cotteswold hills, in Gloucestershire, it is the common husbandry, and often repeated. The sheep-walks and warrens on the Wolds of the East Riding of York, and of Lincoln, have thus been brought most profitably into culture, though not with the attention in cropping that ought to have been given. In Hampshire and Wilts, the same husbandry prevails. In these counties he has been shown lands that have been pronounced ruined by this husbandry. The cropping was bad; but still the rent had been doubled by the practice. In the West Riding of Yorkshire, colonel St. Leger remarks, that if burning wasted the soil, his lime-stone lands, only four inches deep, would have been gone long ago, as it has been pared and burnt for ages. In Kent, Mr. Boys has found it equally beneficial; "If," says he, "any persons who condemn paring and burning, should come into Kent this summer (1795), I can show them several scores of acres of wheat, barley, oats, and sainfoin, now growing on land which has several times undergone that operation. The crops of sufficient value to buy the land at more than forty years purchase, at a fairly estimated rent before the improvement."

With regard to peaty soils, it is stated, that "whatever variety of sentiments there are on this method, for other soils, here there can be none. The universal practice, from the flat fens of Cambridge to the swelling bogs of Ireland, the mountainous moors of the north of England, the rough sedgy bottoms in almost every part of the kingdom, when they are broken up by men of real practice and observation, is that of paring and burning. Registered experiments of doing it by fallowing, are to be met with in various works. The Board's Reports of the North Riding of York, and of Somerset, detail some; others are to be found in his Tours; and the result is either loss, or a profit so very inferior, that the question ought to be considered as settled and done with."

It is added that on heaths and downs "considerable tracts of land, on a weak, thin, loamy sand, with a calcareous bottom, have, within the last five years, been thus broken up on Newmarket Heath, which was done at the expense of 36*s.* per acre, and immense crops the consequence, but in a very bad course, which will by-and-by raise enemies there to this husbandry, though most unjustly." And "the moors and mountains of the north of England, Wales, Devonshire, &c. when broken up for cultivation, are often, and ought always to be reduced by this husbandry. It has long been common husbandry in those countries, and is, therefore,

done cheaper, from 24*s.* to 30*s.* an acre. Draining should precede this operation.

It is advised, that "if the farmer has any old sainfoin layers that are worn out, and which he means to break up, he should determine to do it in no other method than this. If done by mere ploughing, the chances are much against success, by reason of the red worm, which is very apt to abound in these layers, to the destruction of any white corn that can be sown. He has known three successive crops destroyed: to pare and burn for turnips is the safest husbandry in these cases."

In speaking of the different objections which have been made to this practice in fen districts, from the supposition that it tends to reduce the soil greatly, as is evinced by the sinking of drained lands that have been pared, the same writer says, that it has been found that a series of ploughing and cropping stiffens, concentrates, and diminishes the lighter kind of fen soils; and that the stratum of black peat earth, which on their first breaking up was considerably deeper than the plough ran, has been within the memory of the present occupiers, without any fresh paring and burning, so far reduced, that without taking more mould, or ploughing deeper than they formerly had been accustomed to do, they have not only passed the whole of the black peat stratum, but have ploughed up two or three inches of the clay beneath it; and that if it be granted, which he thinks will scarcely be denied, that the surface of the adjacent depastured fen lands, from the decay of vegetables, dung of animals, and the soil brought thither by the waters from the neighbouring high lands, has been continually, though slowly, increasing, there will then appear other reasons for their present different level than mere paring and burning. "It it well known, that earth is not to be dissipated by combustion; is is more likely that this appearance proceeds in the first place from the light peaty earth of a fen soil being gradually consolidated by alternate cultivation and pasturage, so as to sink below the level it formerly preserved in its uncultivated state; and in the next place, may it not proceed from the commons gradually rising higher by the accumulation of mud and soil deposited by the upland waters!"

These facts, which seem to rest upon the foundation of practical experience, sufficiently show that little danger is to be apprehended from the destruction of the soil when the process is properly performed, and a correct method of after-management pursued.

It has been well remarked by Mr. Young that this process "on all soils will give turnips or cabbages; these fed on the land by sheep will secure barley or oats and seeds; the seeds fed with sheep, whether for a longer or shorter duration, will secure another crop of corn adapted to the soil; and in this stage of the progress, the soil will have gained much more than it has lost." And in opposition to the opinion of this management being useful on poor soils, peaty and sedgy bottoms, but not on better sorts of land, the same author observes, that experiment is against it, as "in Yorkshire, land of twenty and thirty shillings an acre has been thus broken up with great success." And besides, on peaty soils, which are the

most rich of any, this is the universal practice. From these and other circumstances, it is on the whole concluded, that the process of paring and burning, with proper courses of crops, is perfectly safe on any soil, and essentially necessary on some, though very rich ones may often do without it.

In the method of performing the process of paring and burning, there are some slight differences in the practice of different districts; and perhaps in managing this business, an attention to the nature of the lands may be as necessary as in other cases of husbandry, as it would seem that some, as those of the more clayey and heavy kinds, would be most benefited by having the fire to come as much as possible into contact with the whole of the superficial parts of them, without being carried too far, as by that means they may be rendered more proper for the reception of the roots of vegetables after being slightly ploughed, as well as more suitable for supplying nourishment to them; while in others, as those of the more light and thin descriptions, it might be most advantageous to merely consume the thin paring of sward after being piled up for the purpose, without permitting the fire to exert its influence upon the mould or soil immediately below, as in this way there would not probably be so much danger of injuring the staple, by destroying the vegetable matters contained in such soils. In the first of these modes of burning the sward, it is obvious, that the sods or parings should be piled up as little as possible into heaps, the advantage of a suitable season being taken to apply the fire to them in the state in which they lie, or are set at first after being cut up, or after a few only have been placed together, as happens in some instances where they are, immediately after being cut, set on edge to dry, and placed in serpentine directions, in order to prevent them from falling over; but in the latter cases they should be formed or built up into little circular heaps or piles, somewhat in the form and size of the little cocks made in hay-fields, the sods being placed the grass-side downwards, in order to admit air; but the openings both at the bottoms and tops, after they have been fully set on fire by some combustible substance, such as straw, &c. are to be closed up, as well as those in other parts covered by an addition of sods; so as that the combustion may proceed in a slow, smothering manner, such as is practised in the making of charcoal. When the whole of the earth in each of the piles has been acted upon by the fire, the heaps may be suffered to extinguish themselves by slowly burning out.

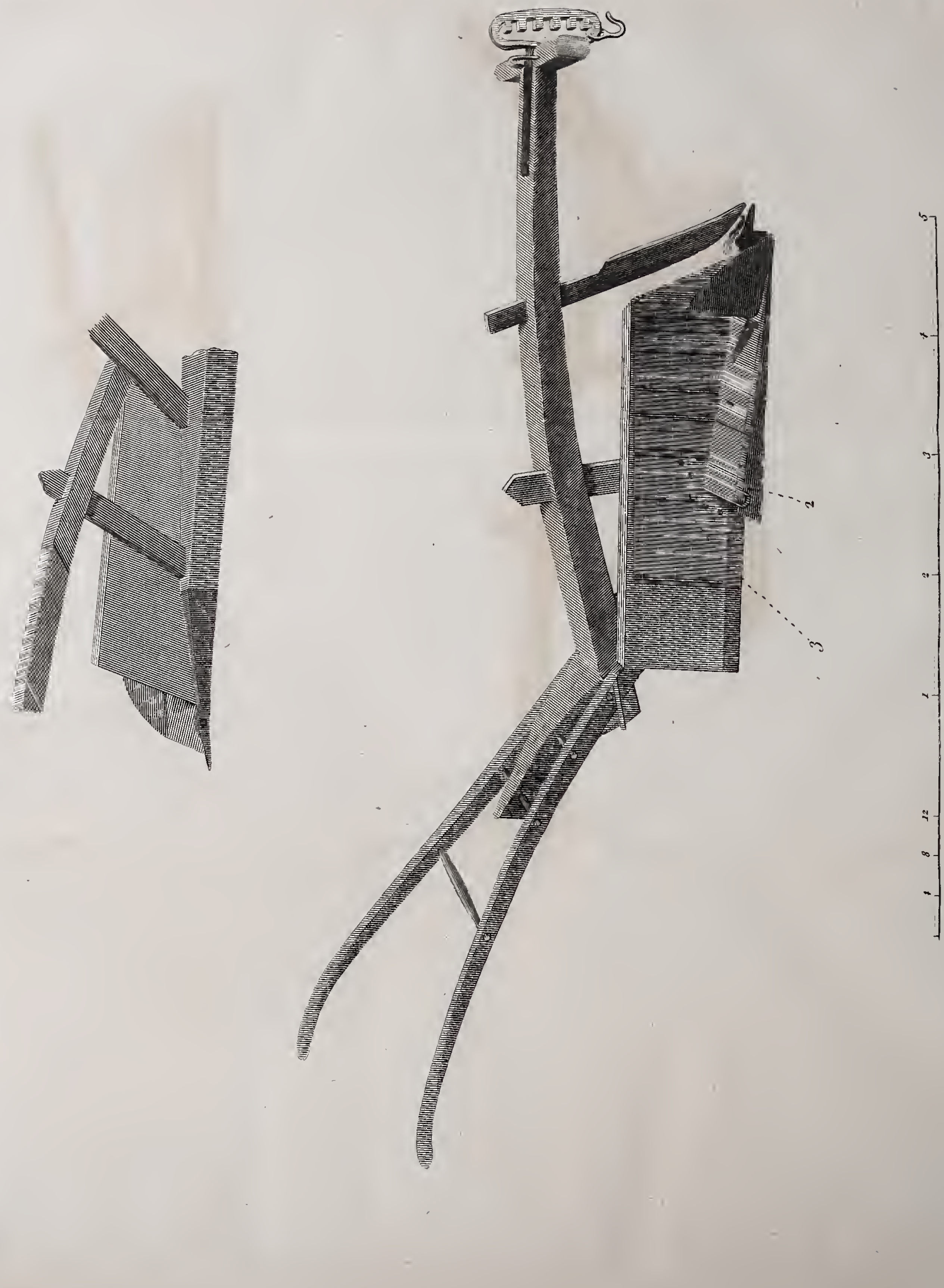
It has been stated by a late writer that in paring heaths, downs, moors, and old sainfoin layers, the heaps should not be made two large—such as contain twelve or fifteen bushels of ashes are quite large enough—as, when made much larger, the turfs are liable to be overburned; but in bad weather they should be larger than in other cases. The thickness of paring must likewise be attended to, as thin flags will burn in smaller heaps than thick ones. After the ashes are spread, which should be the case as soon as possible, they should be ploughed in very thinly. The proper modes of cropping after, are noticed below.

There is another method of practice of this kind, which is much

in use in some districts, as in Devonshire and Cornwall, for breaking up and preparing grass lands for the reception of what have been termed fallow crops, which is that of *skirting*; in performing which a part of the sward or surface is alternately left unturned, upon which the next thin furrow slice is constantly turned, so that the swards of each come in contact, by which means the putrefactive fermentation is speedily excited, and the greatest part of the grassy vegetable matter converted into manure; what ultimately remains undestroyed being, after repeated cross-cuttings with the plough and harrowings, all the mould or earthy matter having been previously well removed from the roots of the plants by shaking, collected into small heaps (which is done either by the hand or with iron-headed rakes, constructed for the purpose), and burnt, the ashes being then spread evenly over the land. The operation when managed in this way is termed *beat-burning*, and would appear to be the most proper and useful on land where the turf or sward is not very tough or matted together, and where there is little or no coarse vegetable product growing upon it.

In accomplishing the operation of paring, or of separating the sward from the surface of the soil, several different instruments are made use of in different parts of the kingdom: that which was the most employed in the infancy of the art was a kind of curved mattock or adz, about seven or eight inches in length, and five or six in breadth; and which from its shape would appear to have been better adapted for cutting up the roots of brushwood, furze, broom, or other coarse shrubs, than for paring off the surface of a field free from such incumbrances. This instrument is, however, it is said, common in the south-western districts; and that, though it no doubt retains in a great measure the shape of the instruments first used for the purpose in that part of the country, when the lands were in a very different state, yet the labourers who are in the practice of using it, are able to pare off the sod with great dexterity and dispatch. But in other districts, where the sod is pared off by manual labour, the ordinary *breast-spade*—in some places called the *breast-plough*, and in Scotland the *slaughter-spade*—is mostly employed. The iron or cutting part of this implement is about eight or nine inches in length, and from ten or twelve in breadth, having frequently a kind of edge rising up a few inches at the right-hand side of the turf next to the unmoved sward. This instrument, which is formed with a fine edge, is forced forward by the strength of the arms of the person using it, and by pressing the breast against that part of the frame or shaft which is held in the hand. In working the tool, the labourer generally cuts the sods at about an inch or an inch and a half thick, and from ten to twelve broad; and when the spade has run under the sod to the length of about three feet, he throws it off, by turning the instrument to one side, and proceeds in the same way, cutting and throwing over the sods, the whole length of the ridge. In this way of performing the operation the labourers, by following each other with a slice of the sward or surface of the land, accomplish the business with much ease and expedition. Meadows and old pastures are often pared by the breast-plough, at an expense of from twenty-

Paring Plough for Rough Land.



five to forty shillings or more per acre, including burning and spreading.

Another instrument that is sometimes used for paring the sod is the *horse-paring-plough*, an implement made of different constructions, according to the circumstances of the ground to be pared. In the fenny districts on the eastern coasts, where paring and burning is practised on a large scale, they have ploughs constructed for the purpose of a particular form, but which vary from the common ploughs chiefly in the breadth and sharpness of the share or sock. They are admirably calculated for paring off the sward or sod of such grounds as are level, and where neither stones, brush-wood, ant-hills, nor other impediments obstruct their progress; but where such obstructions present themselves, the breast-spade or common team-plough, with a small alteration of the share, will be found preferable, both in respect to the extent of ground that can be pared, and the superior manner in which the work in such cases can be performed. In plate LXXXI. are seen two side views of a paring plough, given by Mr. Young, for coarse rough land. The share is six inches in width, and rises or sinks by means of pivot 2, which screws into the holes 3. It is a highly useful implement, being capable of performing its work in cases where the fen-paring plough cannot stir at all. It has been long made use of at Sheffield Place, with much advantage. Ploughs, from their great expedition and regularity of performing the business, should always, probably, be made use of where the nature and situation of the land will admit them, in preference to such tools as require manual labour. In some of the western counties the common plough only is used. There the old grass-fields, when it is proposed to burn the sward, are *rib* or *slob-furrowed* about the beginning of winter; and being again cross-ploughed the following spring, the sods are collected and managed in the manner mentioned in speaking of skirting. In these cases the plough has, however, a wing turned up on the furrow side of the plough-share, by which the furrow is cut any breadth required. The work is also sometimes done by means of the spade, mattock, and breast-plough, in such cases.

The fenny and peaty lands of Cambridgeshire, which are free from large roots and stones, are usually pared by a plough contrived for the purpose, which does it in an effectual manner, turning off a furrow from twelve to sixteen, and even eighteen, inches in breadth, with the depth of not more than one inch. By this means the expense is reduced to not much more than nine or ten shillings the acre.

In respect to the season for performing this operation, it may be observed that the months in which the greatest quantity of land is pared and burned are April, May, and June: the particular period must, however, always depend much on the state of the weather, the nature of the crop, and the farmer's convenience. But for accomplishing the work with the greatest dispatch, and also with the least trouble and expense, a dry season is obviously the best. The prudent farmer should not embark in the undertaking unless there be a reasonable probability of his accomplishing it while the weather

keeps dry and favourable. The latter end of May or the beginning of June, when the hurry of the spring seed-time is over, in the more northern districts, when a number of hands can be most easily procured, may upon the whole be considered as the best and most convenient season; as at this period the green vegetable products are in their most succulent and full states, and of course may probably afford more saline matter; but in the more southern counties either a much earlier season must be taken, or the interval between the hay season and the harvest-time must be fixed upon, the latter of which is, on the principle just stated, evidently the best, where the extent of ground to be burnt is not too large. In other seasons it would frequently be impossible to procure a sufficient number of hands for performing the business. In bringing waste lands into cultivation, where an extensive tract of ground is to undergo this process, the autumn may in many cases afford a convenient opportunity for the operation.

As the crops that are sown after paring and burning are various, and as the season for performing the process must in many cases depend in some measure on their nature, we may observe that when rape or turnips, which are the most prevailing crops in such circumstances, are to be cultivated, the end of May or the beginning of June will be the most proper time: but if barley or oats are to be sown, the paring and burning must be completed as early in spring as the nature of the season will admit; and when lands are pared and burned as a preparation for a crop of wheat, July, or even the beginning of August, may in favourable seasons answer; but it is better to have the ground ready sooner.

The depth to which lands of different qualities may be pared with the most advantage, is also a point that would seem to require some attention in the conducting of processes of this nature; as it can hardly be proper to pare light, thin, stapled soils, to the same depths as those of the more deep and heavy kinds. This should probably, in some degree, be regulated by their particular nature; and their differences in respect to staple and heaviness. Mr. Boys, however, who is in the habit of breaking up thin chalky soils, and such as have been in tillage in this way, observes that in Kent, where the method of paring most in use is with down-shares or breast-ploughs, they take off turfs as thick as the nature of the soils will admit, from half an inch to two inches; the *thicker* the *better*, provided there be a sufficient portion of vegetable matter contained within them to make them burn well. The most usual depths of paring are, however, from one to three inches.

When the season is not very wet, the turfs will commonly be sufficiently dried in about a fortnight or three weeks, even without being turned; but in rainy weather they require a longer time, and must be turned more than once to prevent their striking out roots and shoots, which might hinder them from burning.

When the turfs have fully undergone the process of burning, and are reduced to the state of ashes and a powdery earthy matter, the whole should, as soon as possible, be spread out over the land in as regular and equal a manner as the nature of the work will admit of;

for, without great attention in this respect, great inequality in the crops may take place; besides, the soil will be made lighter in some places than in others, which may be disadvantageous in the same way. The spreading, where it can by any means be accomplished, should always be performed before any rain falls; as where this point is not attended to, a great loss may be sustained by the saline matters being carried down in a state of solution, and their beneficial effects in a great measure lost before the crops are in a condition to receive them. In order to secure the full influence of the ashes, the land is frequently slightly ploughed over immediately after the ashes are spread out.

The expense of preparing lands by the operations of paring and burning must obviously vary according to the situation of the land, the method in which they are performed, and the customs of the district in regard to the price of labour. On the thin sort of chalky soils it is observed that the expense for paring at a moderate thickness, where the land is not very flinty, is twenty shillings per acre: for laying it up in heaps and burning, ten shillings; and for spreading the ashes, three shillings; and that a coat of manure is thus produced on the land of from eighty to one hundred and sixty cart-loads per acre, for the trifling expense of thirty-three shillings. A hundred cart-loads of dung purchased from neighbouring towns and villages, at the distance of three miles from the land, would, he says, cost, carriage home included, ten times the price of down-sharing, and yet would not improve the land more. But that, where the land is well covered with turf, it may be ploughed for burning about two inches deep, with a common plough, drawn by a pair of horses, early in the spring, and as soon as a drying wind sets in, the turf be laid in heaps and burnt by labourers for one pound one shilling per acre, which will produce near two hundred cart-loads. And in some fen districts, where the original surface is rough and unequal, from great tufts of rushes, &c. called *hassocks*, Mr. Young observes, that some persons cut them with spades at the expense of five to ten shillings an acre, and others with the plough. Paths for the horses are in that case to be cut by hand; and the plough made on purpose, and called a *hassock-plough*, cuts laterally much beyond the line of its draught. But opinions are said to be in general, that the hand-work is the cheaper; in either case, the hassocks are dried, heaped, burnt, and the ashes spread. After this they go over it again with a very complete and effective tool, called a *fen-paring plough*, the furrow of which is burnt.

In the management of land by means of paring and burning, it will constantly be necessary to attend to such a mode of cropping as will tend to its improvement, whatever may have been the manner or kind of soil in which the process was performed. When the nature and situation of the land will admit of them, as in the lighter sorts of soils, the growing of turnip or rape crops to be consumed on the ground would seem to be most proper for the first year; then a white or grain crop, as oats, or wheat; after that turnips again, or in some cases, peas, beans, or some sort of green crop, to be eaten off if possible by sheep; and lastly, a grain crop with grass seeds:

but on the heavier sorts of land, where the turnip husbandry cannot be so well introduced, cole, clover, and bean crops, may often be interposed between those of the grain kinds with the most propriety and advantage. And it would seem that the interposition of green crops ought on the whole to be more frequent in the former sorts of soil than on those of the latter, on account of their containing, in general, a less proportion of vegetable matter. It is often attended with great advantage to apply some sort of manure, such as lime, with the second crop of turnips in cases of these kinds.

It is asserted, that in some of the western districts, where the method of paring and burning is very much practised, and held in high estimation, old sainfoin lays, and all such swards as are of a sufficient texture, are usually broken up in this way. Turnips are frequently the first crop; and from the freshness of the land, and the good effects of the ashes, a large crop is mostly produced. But as in those cases the time is too short to get the land in proper tilth for the succeeding crops of barley, grass seeds, and other similar crops, it is often adopted as a better method to sow wheat in the first instance on one ploughing; after which, from the ashes being still fresh in the ground, a crop of turnips may be as certainly depended on, and there is a sufficient length of time to get the land into a complete state of tilth. Wheat stubbles, of the more grassy kinds, which will produce a tolerable quantity of ashes, are also frequently pared and burnt for turnips with a considerable degree of success. In short, when this practice is properly followed up with the turnip and clover husbandry, its good effects cannot, it is conceived, be disputed. In others, cole seed is sown on a shallow ploughing, and never harrowed, in order not to disturb the whole furrow; but rolled, or lightly bush-harrowed. This is intended either for a crop of seed, or for sheep-food: in the latter case, it sells in some places for a guinea an acre; in the former for two or three guineas. Oats are then sown; the crop is productive; and the land, if well laid down to grass, becomes good meadow.

Where there are poor, wet, cold, hungry, pastures and neglected meadows, overrun and filled with all sorts of rubbish, and abounding with too few good plants to render their improvement easy without breaking up, it is observed that these should be pared and burnt; not to keep under the plough to be exhausted and ruined, which is infallible, and the land left in a worse state beyond all comparison than it was before, but to be laid immediately to grass, that is, as soon as the course of husbandry necessary will admit. This, it is conceived, ought to be without variation, under any pretence whatever, in this course of crops: 1st. Pare and burn for turnips to be fed on the land with sheep; but in moist-bottomed lands, rape will often succeed better than turnips, and the sheep feed better with rape upon such lands. 2d. Oats; and with these oats the grass seeds should be sown. The oats and the turnips, it is asserted, would more than pay all the expense of a previous hollow draining, should that be necessary, of the paring and burning, and every other charge; and the change, from a very bad pasture to a very fine one, would all be neat profit. The tenant, it is contended, would be greatly benefitted, and the landlord

find his estate improved, if let, as farms ought to be let, with an absolute exclusion of selling a lock of hay under any pretence whatever.

And it is further asserted, that this method is practised with great success in the *fen land* in Lincolnshire, the business being performed by means of the plough, and cole seed afterwards sown. In some cases, horses and ploughs are found, and the labour put out; which, including a ploughing in order to turn in the ashes, is done at seven shillings an acre: the cole is fed with sheep, and is worth three pounds an acre; but selling price, forty to fifty shillings. Then oats, eight quarters an acre, and ten quarters has been had; then cole and oats again; being laid down with fourteen pounds of white clover, and one peck of ray, the grass lets at twenty shillings. It is found to be a great and lasting improvement of the land. This is conceived to be a low estimate, from the land keeping five sheep an acre, from Lady-day to Michaelmas, and one and a half on the acre in the winter. Where, then, is it inquired, is the supposed mischief of this practice?

There are other sorts of lands, as dry, rough sheep-walks, covered with ling, furze, broom, &c. which should also be broken up in the same manner, but universally to be laid down again with the grasses suitable to the soil and to sheep. On weak thin-stapled land, two crops of corn, after paring and burning, may often be pernicious. Perhaps they might be well laid down without a single one, which would be a better method of management. It is also supposed by some, that it would be better to take, in such cases, two or three successive crops of turnips, in order to completely eradicate all the seeds of the ling, furze, and broom, before the land is laid down to grass, as otherwise these plants may appear with redoubled vigour.

The kinds of grass seeds that may be the most suitable after the operation of paring and burning, must evidently be different according to the nature and quality of the land. In the lighter sorts of soil, those kinds of grasses that cover the earth well will in general be the most proper. On chalky soil sanfoin may mostly be employed to the greatest advantage. On the fenny sorts of soil, marle grass, with a little meadow foxtail-grass, will frequently be found the most beneficial. And a small mixture of the finest ray, or darnel-grass, is likewise found to answer well. For marle grass, though it has some resemblance to red clover, is materially different in its effects; the former being found unfriendly to all natural grasses, while the latter is quite the reverse. This is a fact that has been established by extensive experience. One other very material advantage resulting from the cultivation of marle-grass is said to be, that neat cattle are not so liable to swell by eating it in moist weather, as they are from red clover: nor is its hay so dangerous to the horses' wind as that made from clover.

And it may be further observed, that the heavy or clayey soils will in most cases require the largest proportions of grass-seeds to be sown upon them, in laying them down after this preparation.

From the great ease and expedition with which all those coarse sorts of land, which have been mentioned as proper for being broken up by this means, are rendered fit for the growth of crops of different

kinds, such as those of grain, rape, turnips, potatoes, &c. as well as from the very abundant produce, which is generally the case after such preparation, it cannot be doubted, but that where proper attention is paid to the conducting of the process and the method of management afterwards, it must be highly beneficial, and probably the best that can be adopted. It has indeed been lately remarked, that "when the husbandry that succeeds paring and burning is judicious, no mode of improvement can be compared with it; *for it is certain to produce great crops of turnips and grain, and these are certain means of future fertility in the hands of a judicious farmer.*" And that such kinds of land, when they are returned again to the state of grass after having undergone the processes of paring and burning, generally produce not only a much less coarse, but more sweet and plentiful herbage.

SECTION X.

Fallowing of Land.

In the preparation of land for the reception of grain or other sorts of crops by repeated ploughings, or the frequent exposure of new and fresh surfaces to the action and influence of the atmosphere, a variety of alterations and changes are produced in the earthy as well as other kinds of materials that enter into the constitution of the soils. The heavier or more earthy particles of the land, by being under different circumstances of the air and seasons thus frequently stirred and turned over, are so effectually divided or separated from each other, and broken down, that even in most of the stiffer sorts of ground, as well as those of the lighter kinds, there is a degree of pulverization and mellowness effected, that could scarcely have been induced by any other means; in consequence of which, the portions of vegetable matter that are present, and that may have been reduced into the carbonaceous state, with the calcareous, the argillaceous, and other earthy ingredients, and such metallic substances as may exist in the condition of oxides and calces, become so uniformly and so extensively blended and incorporated, and the manures that are afterwards applied so minutely intermixed with them, that the fibrous roots of the growing crops, of whatever nature they may be, are enabled to penetrate and extend themselves more fully, and of course to draw more regular and varied, as well as more abundant, supplies of nourishment.

Besides, on account of the extreme division and pulverisation that take place, and the great irregularity of surface which is produced in this way, the dews and light refreshing rains, that are so frequently occurring in the early spring months, are more capable of being admitted and diffused through and detained in the hollows and interstices of the ground, and thus of contributing powerfully

to the support of the crops in the more incipient stages of vegetation.

By the repeated turning-in and destruction of different sorts of plants of the weed kind, much vegetable mucilaginous and saccharine matter may also be added, as well as the land improved by the putrefactive fermentation that must from these causes be constantly taking place.

There are also other modes in which advantages may be gained by the repeated turning-over and breaking-down of the particles of soils, as from much of the atmospheric air being by such methods of husbandry blended with the fine particles of the soils, and detained in the numerous hollows and cavities formed by such degrees of pulverisation, a larger proportion of oxygen may be supplied, which, by its union with the carbon and other inflammable materials that are mostly contained in soils, may produce the carbonic or other acids, according to the circumstances of the cases, in greater abundance, and in this manner aid the growth of vegetables in a high degree. And as the water or moisture that is included in large quantities in the pores of soils in such powdery states, may undergo the process of decomposition more fully, by coming more minutely in contact with the portions of atmospheric air that are covered up and imprisoned with it in them, the supplies of ammonia or volatile alkali, by the combination of its hydrogen with azote, may be more regular and more copious, as well as those of nitre, by the more complete union of its superabundant oxygen with some other portion of the abounding nitrogen or azote of such air.

It has likewise been suggested, that as the atmospheric air consists or is constituted of oxygen, azote, and the fluid matter of heat, if the heat that causes them to exist uncombined in the form of gases be drawn away from them by some other material while they are confined in the cavities of the soil, they may by their nearer approach to each other combine so as to produce nitrous acid; or the oxygen, in its fluid state, not in its aërial one, may more readily unite with carbon, and thus constitute a fluid, not an aërial carbonic acid, which is supposed to be of great utility in promoting the growth of plants. And further, that if any process of the putrefactive kind be going on where atmospheric air is in this way confined in the interstices of the soil, and by the deprivation of its heat is converted from a gas to a fluid, the azote may combine with the hydrogen of the decomposing water, or contribute to decompose it, and in this manner form volatile alkali, which, like nitrous acid, may, either during the process of its formation, or after that has been completed, be of very material utility in promoting vegetation, while at the same time the oxygen afforded by the decomposing water may, like that of the atmosphere, contribute to the production of the carbonic, nitrous, or phosphoric acids; and in this way render carbon, phosphorus, and the basis of nitre, capable of being taken up by the absorbent roots of growing plants. From the great diminution of bulk that has been found from experiment to take place where atmospheric air is confined in contact with water, it is conceived that there may be a decomposition of both the water and the

air, and a production of both ammonia and nitrous acid, which are known to be beneficial in promoting vegetation.

In these different views the practice of fallowing may in various instances be highly beneficial, notwithstanding the objections that have been so repeatedly brought against it by writers on husbandry; but at the same time it must be admitted that in some sorts of soil it will, for similar reasons, be much more advantageous and useful than in others. On the lighter kinds of land, where full and luxuriant crops of different sorts of plants, as turnips, potatoes, &c. may be grown, that produce a close, thick foilage, and which, as has been shown by experiment, afford under such circumstances much carbonic acid, (which, from its being greatly heavier than the common air of the atmosphere, must fall upon and be mixed with the soil in such stagnated situations, and thus, together with the more constant moisture that must be present in such cases, promote the solution and decay of various vegetable matters, and continually add carbonaceous and other materials so as to greatly improve the soils,) it can but seldom be necessary. Besides, as in these soils, by the use of the drill, and repeated hand or horse-hoeing during the growth of the crops, the ground may be kept perfectly clean from weeds, and in a fine mellow or powdery state, without the danger of being injured by too much evaporation and exposure in the way of fallowing; and likewise in soils of the same nature, that are rich from the frequent applications of manure, and in which the processes by which the different nutritious substances that have been described are formed and prepared, are properly going on, it must be injurious and improper to expose their surfaces frequently to the influence of the air, sun, and rain, as is the case in fallowing, as by such means the portion of carbonic acid that may exist in the state of a fluid, may be made to assume the gaseous form, and be more readily dissipated, as also the phosphorus and the other materials in their different conditions before they form nitrous acid or ammonia. Thus, besides the injury that may be done in fallowing such sorts of land, by the carbon, and other inflammable materials which they contain, combining with the oxygen of the surrounding atmosphere, and afterwards by their further union with other substances so as to form insoluble compounds, such as phosphate of lime and calcareous nitre, as has been ingeniously suggested by an intelligent writer, there may be others of not less consequence arising from the dissipation and loss of the carbonic or nitrous acid, or of volatile alkali in the gaseous state.

But in all the wet-bottomed, stiff, adhesive, and clayey sorts of soil, which constitute a large proportion of the lands of the kingdom, where, from the closeness of their textures, and the great tenacity of their particles, but a very slight, or indeed scarcely any degree of pulverisation has been effected, the practice of summer fallowing may often be highly useful and advantageous, not only by the great mechanical alterations that must of necessity take place in them by the repeated ploughing or turning up of their parts to the influence of the atmosphere, but by their admitting the particles of the manures that may afterwards be applied, to be blended and incorporated

with them in a more minute and extensive manner; and their becoming so perfectly aërated, as that the different processes that have been mentioned may take place and properly proceed, so as to form in them such substances as has been found of utility in aiding the growth of crops; and which could not possibly have been produced without such pulverisation as is the effect of fallowing.

The degree of friability and mellowness that is produced in this way in such soils has also other advantages, such as those of admitting the roots of the growing plants to penetrate them with greater facility, and presenting a more extensive surface for them to draw their nourishment from. And as in lands of these kinds there is a constant tendency to throw up abundant crops of root and other weeds, it is perhaps only by the frequent turning over of the soil, and the tearing them up by harrowing, as is the case in summer-fallowing, that they can be effectually eradicated and destroyed. It is principally in this view that the working of such soils in the early spring or summer months becomes so particularly necessary; as, at the period in which the seed is to be put into the ground, neither the season nor the state of the weather will admit of their being sufficiently broken down and reduced by ploughing, or the weeds to be destroyed. And it may be added, that wet lands, by being turned over during the winter season, are liable in many cases to become more stiff and adhesive; by which the roots of the crops must be more limited and confined in their means of acquiring nourishment from them.

It has been lately well observed, that "when land of a dry gravelly quality gets foul, it may easily be cleaned without a plain summer fallow; as crops, such as turnips, &c., may be substituted in its place, which, when drilled at proper intervals, admit of being ploughed as often as necessary; whereas wet soils, which are naturally unfit for carrying such crops, must be cleaned and brought into good order by frequent ploughings and harrowings during the summer months." Indeed it is strenuously contended, that the most judicious intermixture of crops upon clay soils will not preclude the necessity of a summer fallow; though it may go a great way in preventing the necessity of its being so frequently repeated. But another writer, whose experience has been considerable, while he allows that there is no question at all of the merit of fallowing when compared with bad courses of crops, and who thinks that, if the husbandry is not correct in this respect, the fallowist will certainly be a much better farmer than his neighbours, contends that there are courses which will clean the foulest land as well as any summer fallow, by means of plants which admit all the tillage of such a fallow. "Cabbages," says he, "are not planted before June or July: winter tares admit of three months tillage, if tillage be wanted. Beans, well cultivated, will preserve land clean, which has been cleaned by cabbages; and in any case two successive hoeing crops are," he thinks, effective in giving positive cleanness.

There are probably, however, many situations of clayey soils so exceedingly stiff and wet, that though turnips, cabbage, or bean crops may be grown upon them, it cannot, from the great labour

and difficulty of their preparation, and the high degree of injury that must be done in the eating or carrying them off the land, be to much advantage, or such as to admit of that sort of culture during their growth that will keep the ground perfectly clean from weeds. In such cases, no course of cropping, however judicious, can probably be effectual in this respect; it is indeed well known to such practical farmers as have had the management of soils of this nature, that it is scarcely possible to be effected even by summer fallowing itself. It has also been justly observed, that soils of this description are so frequently from necessity ploughed over when wet, that an adhesion and sourness is produced that cannot be removed without exposure to the heat of the summer's sun, and the pulverisation afforded by the repeated operations of the plough and the harrow. There is no sort of crop that can in such cases supply the place of fallow, as turnips are highly detrimental; and drilled beans, though they may answer in the way of an assistant to fallow, and have the tendency of keeping lands clean that are already in a proper condition, it is supposed, from the necessity there is of sowing them early, can never be beneficially substituted for the radical improvement that is produced by a clean summer fallow.

But even if such sorts of land could be kept perfectly clean and free from weeds by the judicious interposition of bean, cabbage, or other similar crops that might be cultivated on them, it is evident that the various beneficial products which have been mentioned, and which are the result, in a great measure, of the perfect pulverisation and high degree of aëration that are produced by means of summer fallowing, could never be formed in such an abundant manner as to be of much utility in aiding the growth of crops. Nor could they be in so suitable a condition for the admission and extension of the absorbent roots of the plants that may be cultivated upon them.

Yet though these circumstances may demonstrate the practice of fallowing to be occasionally necessary, and highly useful, on such wet, adhesive, clayey soils; as the proper and most advantageous quantity of stock for the improvement of such farms can seldom be kept where it greatly prevails, the repetition of the practice should, in this view, be prevented as much as possible, by the cultivation and growth of green crops as often as the lands may be in a state fit for them, and they can be had recourse to with any chance of success. The *Ruta Baga*, or Sweedish turnip, as being a plant somewhat more adapted to wet, stiff soils, than either the common cabbage or turnip, might probably in such cases be advantageously substituted as a green crop, and, by being eaten off in the spring months, when the ground became sufficiently dry to bear the cattle or sheep without injury, admit of a pea crop; after which the land would probably be in a suitable condition for wheat; or a crop of clover might be taken, and then wheat. But in all such cases much must depend upon the degree of cleanness, pulverisation, and aëration, that has been accomplished by the occasional use of summer fallowing.

There is much variety in the conditions of such soils as may occasionally require the aid of naked or summer fallowing, in order to

render them suitable for the growth of clean grain or other crops; some, from the nature of their situation and the sub-soils on which they are placed, being more inclined to the retention of injurious moisture or wetness than others, consequently more disposed to be cold, and to the throwing up of large crops of weeds; while others, from the large proportion of clayey or tenacious loamy materials that may be mixed and incorporated with the pebbly or other ingredients, may be more stiff and retentive, and of course more difficult or more incapable of sufficient pulverisation, and of admitting the roots of such plants as are capable of being cultivated upon them, to readily establish themselves and draw from them proper supplies of nourishment.

In regard to the method of performing the operation, it should always, like most other processes in husbandry, be conducted with a due attention to the circumstances and qualities of the soil, as more pulverisation or breaking down will evidently be required where the land approaches to the nature of a perfect clay, than where it has more of the loamy quality; and where the retention of moisture is considerable, more regard will be necessary to the destruction of weeds, than where there is a greater tendency to dryness. In most cases where the practice of naked fallowing is thought necessary to be performed, the most general method of proceeding is, for the land to be first ploughed up in autumn, a second time after the barley seed season is finished, and two or three times or oftener afterwards, as circumstances may render necessary; the ground being well broken and reduced by means of harrowing in the intervals of the different ploughings. It has likewise been long since judiciously recommended, both in the preparation of lands by winter fallowing for barley crops, and summer fallowing for those of wheat, that when it is first ploughed up after the harvest is over (which should always be done as deep as possible), no time should be lost in rendering the new-turned up soil as fine as possible by harrowing; as repeated trials and attentive observation have fully shown, that such lands as are made fine before the sharp frost and winter rains come on, receive a much larger share of their influence than any others; but that, if the land be left in a rough state, there is seldom time for the rains and frost to penetrate or affect more than merely the outside of the large clods or lumps that are present. The outside may thus, indeed, be pulverised; but the middle of the lumps, wherever they are large, is found nearly in the same hard, stiff atate, as when turned up by the plough. Hence it is evident that the benefit of the air, winter rains, and frosts, on lands thus left, must be only partial; and that of course the harrowing it in the spring, especially when the latter of these are over, is too late for its receiving the full benefits which might otherwise have accrued from them, and the power of promoting vegetation not being nearly so great. Therefore, to make winter fallows as fine as possible in autumn, and then ridge them up in that pulverised state, is acting most agreeably to nature: the greatest possible quantity of surface being thereby exposed to the atmosphere, and the land left in the state wherein the rains and the frosts are most easily admissible; they are consequently more capable of pene-

trating and enriching the whole mass to a much greater extent. By this means, too, a larger proportion of atmospheric air is involved and incorporated with the mould, and of course a more perfect degree of aëration effected. There cannot be much doubt, but that by well reducing such stiff, adhesive soils as require fallowing, on their being first ploughed up, great advantages in the way of pulverisation may be accomplished, as in the spring and summer months they are apt to cake, and become so hard and lumpy as to be wrought with difficulty. In order to fully ascertain the utility of this method of preparing fallows, one half of a field of ten acres was left as nearly of an equal quality as possible, in the rough state after ploughing; while the other was made very fine, by harrowing and beating in pieces any large hard clods which the harrows could not reduce. In the following spring it was observed, that that part which had been harrowed was much finer without any additional working, than the other could be rendered by repeated harrowings.

It is therefore evident, that upon most sorts of stiff, clayey soils, where fallowing becomes necessary, the first ploughings should be given if possible before the commencement of the winter season, and that they should also be well reduced by means of harrowing, in order to promote the decay of such vegetable matters as may be upon the surface of the land, as well as to produce a more complete state of pulverisation and aëration of the soil. This is often most usefully performed by gathering up the ridges; as in that way the ground is not only laid more dry, but the furrows more effectually opened for the draining off of the injurious moisture. In the second ploughing in the spring, which is generally before the cross-ploughing is given, these ridges ought to be cloven or turned back again, and, after lying a suitable length of time, be well harrowed for several times, and occasionally rolled, that sufficient opportunity may be given to collect and remove every sort of weed that may be brought up to the surface. After this business has been properly performed, the land may be again ridged up by means of the plough; by which it is rendered less affected by wetness, and the portions of soil that had not been touched in the cross-ploughing stirred. In this way a perfectly clean fallow may soon be procured. It has, however, been maintained by some writers who have had much opportunity of examining the matter, that ploughing only is necessary; the collecting the roots of the weeds and removing them being useless and improper. But in the stiffer sorts of clayey, wet soils, where we have conceived the fallowing system to be chiefly occasionally necessary, it is almost impossible to get perfectly clear of different sorts of root-weeds in this way, from the cloddy manner in which such lands break up in the operation of the different ploughings, the earthy lumps often containing many that are not in the least degree injured in their power of taking root, by the heat to which they may have been exposed in such ploughings. In these cases, they can only perhaps be effectually eradicated and destroyed by the high degree of pulverisation that may be accomplished by means of frequent harrowing and rollings; the weeds being afterwards carefully removed by the hand.

In Norfolk they occasionally make what is called a *bastard summer till*. If a piece of land, from which they have mown a crop of clover or any artificial grass, appears to be not sufficiently clean for the ensuing wheat-crop, they plough it twice, and, if there is time, thrice before harvest, using freely both the roller (if it is necessary) and the harrow. They sometimes even make a *bastard* summer-till of a pea-stubble, for the purpose of cleaning it. As soon as the peas are off the land, which often times happens four or five days, and sometimes a week, before the harvestmen are taken home, they harrow the haulm up and cart it off; plough the land once immediately, and let it lie till harvest is over; then give it two cross ploughings, and a fourth preparatory for seed, which, however, is oftentimes ploughed in with the last earth.

In cases where manure is necessary to be applied to land after it has been prepared by the process of summer fallowing, it should be done according to the nature of the manure and the circumstances of land in respect to richness and the state of its tillage. Lime or marle are generally laid on with the greatest benefit during the summer months, as about the middle of July or the beginning of August; in which cases it should be spread out as equally as possible over the land, and ploughed in with a very slight furrow, so as only just to mix and incorporate it with the mould; as by this means, where farm-yard manure is applied at the time the seed furrow is given, in a similar manner, the calcareous and vegetable manures, by being thus more uniformly blended with the soil, as well as by their more extensive operation on each other, afford more abundant and regular supplies of nourishment to the crops during the first stages of their growth, and a degree of heat may be generated that is highly favourable to such states of vegetation. That some advantage is afforded in this way is evident, from the rapid growth and great verdure that generally take place where fallows have been managed in this manner.

In some cases of land after fallowing the application of manure may, however, be wholly unnecessary, as from the great destruction of weeds, and the advantages produced in the different ways that have been mentioned, such improvement may be given as to endanger the first crop by rendering it too luxuriant, and consequently liable to be lodged before it becomes ripe, if manure be applied the same season. Very strong crops of grain have, indeed, frequently been produced on fallowed lands, without the smallest quantity of manure having been put upon them. In such instances, therefore, it will be more œconomical and advantageous to make use of the dung with a view to the second crop that may be cultivated on the land, and not that which immediately follows the fallow.

Though the advantages that have been stated to arise from the perfect pulverisation, aëration, and cleanness, occasioned by summer fallowing, in those soils where it has been found to be occasionally requisite, can seldom be so fully obtained by other methods of cultivation; yet as that method is constantly attended with a heavy expense to the farmer, and as many of the benefits that are

produced by it may be effected by the repeated partial fallowings that must occur in the hoe-culture of different sorts of crops, it should be constantly the aim of the agriculturist, where the climate will admit of it, to lessen the necessity of summer fallowing, even on the wet clayey as well as the light kinds of soil, by the judicious interposition of such sorts of close, thick, green crops as can be grown and cultivated on them under the hoe system. This is still more necessary, on account of the loss that must be sustained from the land often remaining such a great length of time totally unproductive where the fallowing process is going on. It cannot, indeed, be disputed, but that the practice of summer fallowing may be greatly lessened in many districts by the proper substituting of green fallows, or what are termed fallow crops; such as beans, peas, cabbages, tares, and rape, for the heavier sorts of land; and buck-wheat, potatoes, and turnips, for such as are of the lighter kind. It is likewise maintained as a fact, that where large and luxuriant crops of these preparatory kinds are grown, those by which they are succeeded the following season are for the most part still larger, so that the lands are more improved by large crops than such as are poor. This amelioration or increase of fertility has been attributed to different causes: as the prevention of evaporation from the soil by the shade produced by such large crops; the putrefaction of the various vegetable matters, which may be more abundant after such large crops, taking place more completely and more effectually under such circumstances; and lastly, to the repeated pulverisation and aëration that are produced by the different hoeings: but it is probable that advantages may be derived in each of these ways, as well as from the carbonic acid, or fixed air, that is afforded by the shaded leaves of the plants being deposited upon or united with the soil. But in whatever manner this effect may be produced, as it is constantly found that land is in a better condition, and, when turned up, in a more friable and mellow state, after such crops as are large than those that are poor and light; it is of course evident, that if ground can be covered with such smothering crops of the fallow kind, or those that will admit of frequent pulverisation by means of the plough or hoe, as to keep it clean and free from the growth of useless plants, it may be more beneficial to the agriculturist, not only for the sake of the immediate crop, but also on account of the increase of manure produced by such means, and the advantageous condition of the land for the reception of such crops as may be afterwards cultivated upon it.

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